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ARTICLES

RADIOACTIVE ISOTOPES IN AGRICULTURAL RESEARCH

By T. H. ODDIE

Introduction

In most branches of science one finds that radioactive isotopes were first applied by Hevesy; plant studies are no exception because as early as 1923 he (Hevesy, 1923) used radiolead, ThB, to follow the movement of lead in plants. Since then, the discovery of artificial radioactivity in 1934, the separation of stable isotopes, and the release of pile-produced radioisotopes for research use in 1946 have enabled tracer methods to be extended to include all the chemical elements. The principles of such methods, however, remain the same, and it is fitting that Hevesy (1948) has recently written an historical sketch of this subject.

In this article it is not possible to refer in detail to the large volume of published work on the biological applications of isotopes, but only to indicate a few sources of more complete information.

Properties of Isotopes

Data based on information available up to October, 1948, have been tabulated by Seaborg and Perlman (1948), covering known isotopes, both stable and radioactive.

For biological work the following properties of the radioactive material are important:—

(a) *Half-life for radioactive decay*

Quite apart from any experimental dilution that may occur, sufficient active material must be applied at the beginning of an experiment to allow a measurable amount to remain at the end. For example, radio-phosphorus ^{32}P has a half-life of 14.3 days, so that radioactive decay during an experiment lasting six weeks (about three half-lives) would leave about $(0.5)^3$ or 1/8 of the original amount available for measurement at the end.

(b) *Radiation emitted*

Nearly all isotopes used in tracer work emit β rays, sometimes accompanied by γ rays, while a few give off soft X rays. It is, of course, the type and energy of the emitted radiation that determine the sensitivity and sometimes the choice of a method of measurement (Oddie, 1950).

(c) *Isotopic purity or specific activity*

Depending on the method of production, radioactive isotopes are available mixed with a certain amount of the stable isotope of the same element; some can be made "carrier free", that is with only trace amounts of the stable isotope present as impurities; on the other hand others can only be supplied mixed with relatively large amounts of the stable material, when they are said to be of low "specific activity".

From the above it will be apparent that only isotopes with reasonably long half-lives are of much use for biological tracer experiments. Fortunately there are usable radioisotopes for most of the chemical elements, with the notable exceptions of oxygen and nitrogen. In the latter cases material isotopically enriched with the stable heavy isotopes ^{18}O and ^{15}N

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must be used instead. Other stable isotopes that have found common use are ^{2}H, ^{13}C, and ^{34}S. Techniques of assaying such materials have been reviewed by Morrison (1950).

Measurement of Radioisotopes

In the detection and measurement of radioisotopes use is made of the radiation emitted during their decay. Many special techniques have been developed for such work, depending on the material to be assayed and the isotope used.

For biological work the methods of most interest are as follows:—

(a) *Geiger counting of liquid samples*

As little as 10^{-4} to 10^{-3} microcurie (μc) of many radioisotopes may be measured in solution in the skirted type of Geiger counter developed by Veall (1948). The method is not suitable for ^{14}C, ^{35}S, or ^{3}H, which emit only weak β rays unable to penetrate the glass walls of the counter.

(b) *Counting of solid samples under end-window type of Geiger counter*

Solid samples of nearly all radioisotopes may be assayed under an end-window type of Geiger counter (Brown, 1948; Oddie, 1950), which will measure about 5×10^{-5} μc of material.

(c) *Internal sample counting*

A rather more sensitive method, particularly for ^{14}C assay, is the use of a proportional counter (Korff, 1950, 1951) with the solid sample inside, or a counter with a radioactive gas filling (Eidinoff, 1950).

(d) *In vivo counting*

When the labelling material emits γ rays the latter can be detected at a distance through quite thick layers of material. In this case it is possible to study the behaviour of isotopically-labelled material *in vivo* without disturbing the organism being studied. It is, however, necessary to use relatively greater amounts of radioactivity—of the order of 5 to 100μc.

(e) *Autoradiographs*

The location of radioactive material in thin sections of plant or animal tissue can be observed photographically by the autoradiographic technique. Good general articles on this subject have been written by Doniach and Pelc (1950), Gross and others (1951), and Hertz (1951), and typical examples of work with plant tissues may be found in papers by Russell and others (1949), using ^{32}P, and Millikan (1951), using ^{54}Mn.

Types of Applications of Radioisotopes

Tracer applications

All tracer applications are similar in principle; part of one component of a system is labelled and the system is allowed to react for a given time, after which the distribution of the labelled material may be analysed to give the course of the reaction, the metabolic rate of the labelled component, or similar information. The component that is labelled may be an atom, an ion, a radicle, a molecule or even a whole organism, but it is necessary to be sure that the label remains attached to the component being studied throughout the experiment, and does not exchange with other similar non-labelled components.

The use of labelled atoms and ions is exemplified by work on ion exchange, adsorption and translocation in plants (Biddulph, 1941; Brewer and Bramley, 1950; Overstreet and Jacobson, 1946; Steward, 1948). Similarly sulphur metabolism in plants has been investigated with ^{35}S as elemental sulphur (Turrel and Chervenak, 1949; Yarwood and Jacobson, 1950) and as sulphur dioxide (Fried, 1948; Thomas, Hendricks, and Hill, 1950), and it has been shown that sulphur, as S or SO_2 in the air, S applied as an insecticide, or SO_4^{--} in the soil, can enter the plant where it can be converted to organic form provided that top growth is present.

Labelled molecules are involved in such investigations as those of Mitchell (Mitchell and others, 1947; Mitchell and

Linder, 1950) who traced the movement of ^{131}I-labelled growth-regulating substances in bean and oat plants. In work of this type it is usually necessary to consider first in some detail the preparation of the labelled compound (Downes, 1950), particularly the radioelement to be chosen and its position in the molecule; sometimes compounds can be doubly-labelled with two different radioelements, or two experiments can be made with the same compound singly-labelled in different positions.

When whole organisms are to be labelled, the above choice of labels is also present, and it is best to select an isotope of convenient half-life and easily-detected radiation. Thus external labels of ^{60}Co wire have been attached to insects and used to observe their movements under the soil (Arnason, Fuller and Spinks 1950; Fuller and others, 1950), ^{32}P has enabled the range of flight of labelled houseflies to be measured (Anon., 1951), mosquitoes may also be marked with this material (Jenkins, 1949; Yates and others, 1951), and poultry-feeding investigations have been made with labelled grain of corn grown with ^{32}P in the nutrient solution (Jacobson, 1948).

Microchemical studies

Another field of considerable use for radioisotopes is in the assay of minute amounts of materials, where the sensitivity and ease of measurement are often much greater than those of ordinary micro-chemical methods. Thus Mitchell and Linder (1950), in their experiments with growth regulators, were able to detect easily 10^{-7} g. of chemicals, and work with trace amounts of materials becomes comparatively easy provided that the required radioelements are available without too much carrier (inactive isotope) present.

Trace element studies have been made, for example, in plants with ^{99}Mo by Stout and Meagher (1948), and with ^{54}Mn by Millikan (1950), in animals with ^{64}Cu, ^{99}Mo, and ^{65}Zn by Comar and his co-workers (see review by Comar, 1948), and in hornets with ^{140}Ba by Bowen (1949).

The high analytical sensitivity of radioisotopic methods has also been used to advantage in measuring small quantities of insecticides (Winteringham, 1951); thus the field dispersal of DDT in concentrations as low as 0.001 lb./acre has been checked by mixing it with radiomanganese (Anon., 1948), and David (1950) has used ^{32}P to trace the course of the insecticide bis-(bis-dimethylamino)-phosphonous anhydride from a nutrient solution, through the leaves and runners of broad bean plants to the honeydew of aphids feeding on them.

Use of effects of radiation

In all the work mentioned so far, the radiation given off by the tracer material is used solely as a means of detection and measurement. The well-known biological effects of higher intensities of radiation are also being examined with radioisotopes (Spinks and others, 1948a; Beal, 1949), particularly genetic effects in potatoes (Stanton and Sinclair, 1951) and in maize and corn (Singleton, 1951; Koester, 1951).

On the other hand detailed claims by French (1948) that certain α-emitting radioactive materials, when used in conjunction with commercial fertilizers, exert a "very marked influence on the increase of yields" of crops, have recently been disproved by Alexander (1950), whose comprehensive field tests have shown that such materials have no effect on the yield, harmful or beneficial, with a probability limit of 0.05.

Problems in the Use of Isotopes

While isotopic methods have opened new and large possibilities for biological research, it is well to keep in mind certain limitations on their use, the chief of which are tabulated below. A full discussion of these may be found in papers by Harris (1950), Rogers (1950) and Stevens (1950).

(i) As mentioned earlier an isotope must be available with a suitable half-life and high enough specific activity, so that the biological system being studied will not be affected by the inert carrier accompanying the tracer material.

(ii) A suitable labelling method must be found, and the label must remain "in place" during the experiment.

(iii) Possible "isotope effects" must be considered. Thus although isotopes of one element behave almost identically in chemical reactions, small differences do occur. Normally these are negligible and they will only become apparent when there is a large percentage mass difference between the normal atom and the labelling atom, particularly with ^{2}H or ^{3}H labels (see, for example, Govaerts and Leclerq, 1947; Weigl and Calvin, 1949).

(iv) In tracer work it is assumed that, for the duration of the experiment, radiation from the labelling material has a negligible effect on the process being studied. In biological systems this is not always the case, because higher intensities of radiation do have quite a marked effect on many organisms. This danger is increased when local accumulations of the isotopic material may occur, giving rise to points of increased radiation intensity. Such an accumulation of ^{32}P on root tips was first demonstrated by Russell (Russell, Adams and Martin, 1949; Russell, 1949), who criticised earlier work (for example, Spinks and Barber, 1947-48; Spinks and others, 1948b) with this radioelement in studies of plant uptake with various forms of phosphate fertilizer. In later papers Dion, Dehm and Spinks (1949) have described more-carefully-planned experiments showing no damage to the top growth of wheat grown on fertilizers with 35-360 μc of ^{32}P present per gram of phosphorus; they did not give data, however, on possible root damage. Since then further studies of this problem have been described by Blume, Hagen and MacKie (1950), Parker (1950), and Bould, Nicholas and Thomas (1951), showing that ^{32}P radiation effects are on the whole small; for barley the lowest level for damage to appear was 5600 μc/g P_2O_5 and the ratio $^{32}P/^{31}P$ is as important as total ^{32}P in determining possible effects.

To avoid the pitfall of possible radiation damage it is recommended, therefore, that experiments should be planned with a statistical layout covering two or three levels of tracer material, and that such levels should be as low as possible while allowing sufficient activity for accurate radio-assay.

(v) Finally, in all work with radioactive materials, care is necessary to avoid hazards to those handling them (Stevens, 1950), and even for tracer amounts of short-lived isotopes contamination of equipment and cross-contamination of samples must be avoided if accurate experimental results are to be obtained. In some field tracer work, large amounts of material may need to be handled, requiring the design of special equipment; for example, Cumings, Hulbert and Eldridge (1950) have described a special shielded dispenser for applying radioactive fertilizer uniformly in field studies.

Scope of Tracer Studies in Agricultural Research

The use of isotopes as tracers in plants up to the middle of 1948 has been reviewed thoroughly by Burris (1950), and a number of later papers have been referred to above. Other work of interest includes the use by Bonner (1949) of ^{14}C to study the natural synthesis of rubber, and the measurement of root extension in

grape-vines with ^{32}P by Lott and others (1950).

Entomological applications have been reviewed by Day (1950) and by Jenkins and Hassett (1950), while more recent work with soils will be found in papers by McAuliffe and others (1948), White, Fried and Ohlrogge (1949), and Harris and others (1951).

It is not possible here to refer to more than a very few of the many applications of isotopic techniques to animal investigations. A paper by Hansard (1951) gives useful information on techniques suitable for animal studies with isotopes. Since the early paper of Hahn and Hevesy (1937) with ^{32}P on the origin of yolk lecithin, much work has appeared dealing with eggs, chick embryos, and metabolic processes in laying hens; later papers are those of Comar and Driggers (1949), Hansborough and Nicholas (1949), Spinks, Berlie and O'Neil (1949), and Kritchevsky and others (1951). Similarly, many experiments on milk formation have been made using radioactive phosphorus, iron and strontium, the latest paper noted being that of Kleiber, Smith and Ralston (1948), who found the time-relation of ^{32}P incorporated into milk after intravenous injection. Finally, investigations of animal parasites have been assisted by means of tracers: the distribution of radioantimony has been examined in dogs infected with *Dirofilaria immitis* (Cowie and others, 1945; Brady and others, 1945); Lawton and others (1945) have made a similar study with radioarsenic in cotton rats infected with *Litomosoides carinii;* Read (1950) has measured the uptake of labelled phosphate in the tapeworm, and Thompson (1949) has used radioiron in work on avian malaria; in Australia Rogers and Lazarus have labelled phenothiazine with ^{35}S in order to find the uptake of this drug in the tissues of nematode parasites and their hosts (Rogers and Lazarus, 1948; Lazarus and Rogers, 1950, 1951).

The above examples will show the extent to which isotopes have already been applied in agricultural research and in allied fields of science. It is to be expected that these techniques will continue to find increasing use, not only in true tracer problems but also in cases where trace amounts of materials are involved.

Acknowledgment

The writer is grateful to Dr. G. M. Harris, of the Chemistry Department, University of Melbourne, for helpful discussions on the preparation of this article.

Supplies of Isotopes

For Australian use supplies of isotopes may be obtained as follows:

Stable isotopes

^{13}C and ^{15}N are sold by the Eastman Kodak Co., ^{2}H as heavy water is sold by Imperial Chemical Industries, and a limited stock is held by the C.S.I.R.O. for distribution at cost price to research users.

Radioactive isotopes

Details of materials, labelled compounds, and prices, are given in a catalogue compiled by C.S.I.R.O. (1951).

Applications for radioisotopes for non-C.S.I.R.O. use should be made to:

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THE USE OF MANAGEMENT TECHNIQUES IN AGRICULTURE

By W. G. MEADLEY

From the popular biographical sketch "Cheaper by the Dozen" the layman has recently tasted the romance of the development of the science of management and has probably obtained some vague conceptions and, not improbably, misconceptions about the principles and methods of scientific management. The principles and methods which have been formulated in this discipline are applicable to almost any form of human activity and may even be applied to promote smooth-running harmony and achievement of aims in the domestic menage. They have no small contribution to make to agriculture and it seems desirable that the agriculturist should clarify his conception of these principles, acquaint himself with the applications which are being made in agriculture overseas and so add to the tools with which agricultural efficiency may be enhanced. This short paper is intended to draw attention to management techniques and to stimulate exploration of their possible use in agriculture in Australia.

Management techniques

The techniques of scientific management are the principles with the aid of which, for each situation, the aims, plans, methods, schedules and controls which represent the most economical use of human and material energies may be discovered and established. These techniques or tools are in themselves simply applied "common sense", but the formulations of numerous workers in this field have reached such an advanced stage that only a person of uncommon sense would, without taking advantage of paths laid down, be aware of them or their potentialities.

Scientific management was born about 1880 as the thoughtful innovations of Frederick W. Taylor, who was manager of a steel plant. It was developed by Gantt, the Gilbreths and others and has been successfully used by industry for the last 30 or 40 years. It has found its greatest use there because industrial enterprises operate under the leadership of comparatively few persons who can, if they so desire, employ management engineers to design methods and processes. Furthermore, these designs may be carried to a very high degree of refinement where large concentrations of individuals are employed, under direction, in highly repetitive tasks on standardized materials yielding identical products.

In agriculture, the situation is radically different. Here are millions of managers, each with a small unit, each unit generally having a diversity of products and each product demanding a complex series of operations. Each product and each operation is subject to a large number of variables such as weather, soils, diseases and pests. A farmer therefore requires very practical and adaptable principles of management. In spite of the diversities and complexities many of the techniques of scientific management can be applied.

Good management on the farm calls for much more than a random selection of machinery or farm practices or even the mere improvement of methods. Among the things which have to be considered are the practical principles of motion economy, work simplification, simple

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methods of planning and scheduling and elementary financial control. Most farmers have to be their own production engineers in a small way.

As in industry, scientific farm management must follow an orderly process for defining objectives, selecting suitable materials and facilities, determining the best possible methods under specific circumstances, then making plans and setting schedules with just enough follow-up to ensure completion. The use of such a process makes the farmer master of his situation. With this mastery he can better utilize available ideas, goods and services to increase his output to still higher levels.

Let us now examine several specific management techniques which have been applied to agriculture and can be further applied if farmers generally wish to raise their level of productivity.

Budgetary control

We all know that governments and industries use budgets to forecast their income and expenditure. Indeed, many industries prepare highly accurate forecasts of their net profit up to 12 months ahead. The types of budget which could well be prepared even in the smallest agricultural enterprises are:—

(1) *Sales or Production Budget.* This is done in many cases without its importance being realized. A farmer may decide to plant 300 acres in wheat. He may assess what this will return him in cash. If he continues this process and covers all his activities as far as production is concerned, he has then established a sales or production budget.

(2) *Materials Budget.* To achieve the production proposed it is necessary either to utilize stocks of materials on hand such as seed, wheat-sacks, fertilizer, or to arrange to purchase these necessary materials. A materials budget would schedule over the year both purchases necessary for immediate use and for stock in future years.

(3) *Labour Budget.* As for materials, an assessment can be made of the labour which will be required for the proposed production and for maintenance and construction. It should be possible to plan exactly the labour force required throughout the year and this requirement may be converted to cash figures representing payments which have to be made.

(4) *Expense Budget.* This provides for all indirect operating expenses such as professional fees, brokerages and commissions, transport costs, etc.

(5) *Maintenance Budget.* It is the exception rather than the rule to find maintenance given any consideration other than as a "fill-in job". To most farmers, careful consideration of maintenance and maintenance costs could mean a substantial saving in investment in new plant and equipment.

(6) *Capital Expenditure Budget.* Most farmers incur some capital expenditure each year but many do so without careful planning. Probably an annual plan for capital expenditure is too short-range a policy and it may be necessary to plan up to 7 years in advance.

(7) *Cash Budget.* If each of the foregoing budgets are analysed with regard to time of incurring expenditure and of accruing income, it is possible to prepare the cash budget. This is by far the most important budget but it depends for its final construction on careful preparation of all the others. With it the farmer is able with some accuracy to forecast his cash or credit position some months ahead. He is able to amend or adjust his plans to suit his finances.

This may sound relatively simple. We might believe that every farmer does something along these lines. A recent survey in Great Britain has shown that a number of large-scale farming businesses discount the value of financial budgets and even discount the management value of accurate accounts and records.

Under the conditions today, where many of those engaged in agriculture are enjoying considerable prosperity, budgetary planning and controls may not seem necessary. If economic conditions were to change even slightly, it could well be that those who are using controls of this nature would avoid financial difficulties. Those who are not using these controls do not know where they will find themselves. Which course should a prudent man take?

Cost control

In any given area some crops or types of agricultural production are much more profitable than others. This type of knowledge needs a sound quantitative foundation. It becomes necessary to have cost information to guide us to the type of product we should grow, to decide,, for instance, whether that sideline in pigs is worth undertaking. We should compare constantly our actual costs and achievements with those on which we based our decision to grow a particular product. This calls for a much more detailed approach to costs and accounts than is usually made. Progress cost of production figures should be taken out monthly and the adverse effects of excessive costs carefully assessed in relation to the overall budget. The book-keeping procedures to maintain the necessary cost records are relatively simple. Due either to lack of knowledge of these procedures or to lack of appreciation of their value, cost control is not frequently practised.

Work simplification

Work simplification is the systematic analysis of work methods by which the easiest, most effective and most economical way to do a job is searched out, developed and put into use. The aim is to develop improved work methods which maximize output and minimize fatigue, time expenditure and cost. Work simplification embraces several other tools which are specifically used by methods engineers. Among these are time and motion study, process charts and operation analysis. In this country there has been very little systematic work on simplification of agricultural tasks, except in the sphere of agricultural machinery. Manufacturers of some classes of equipment have endeavoured to produce equipment which gives high output with low labour cost.

Some of the principles of work simplification may be described as follows:—

(1) The job as it is done is analysed in the greatest detail into the smallest component parts or operations. Delays and idle time, movements of materials, travel, postures adopted and all other details are set down.

(2) Every operation or element of the job is questioned as to whether it is necessary, what is its purpose and where, when, how and by whom it should most conveniently and effectively be done.

(3) In light of these queries, unnecessary details are eliminated, separate operations are combined into one, operations are arranged in better sequence and motion sequences are reduced to the fewest possible basic elements. Delays and idle time can often be eliminated or made use of.

(4) For hand tasks, various principles are followed. Both hands should be occupied in useful work and should generally work fairly close together. Motions should be simple and of a continuous curved nature rather than jerky. Essential tools, materials and facilities should be kept within easy reach and should not be laid down unnecessarily, to be picked up later.

(5) The following miscellaneous principles pertaining particularly to the layout of the scene of operations are applicable to farm work. Buildings and work areas should be situated as close together as possible and circular travel should be provided for. Gates, doors and steps should be kept to a minimum and where fences are necessary convenient gates should be wisely situated and well main-

tained. Paths, alleys and doorways should be sufficiently wide, level and smooth for the use of wheeled transport. Equipment, facilities and supplies should be situated where relevant work is to be done. Work areas and procedures should be arranged so that materials and supplies are handled as few times as possible. Where possible, gravity should be used to move goods. Adequate light and safe working conditions should be provided.

(6) When the best way of doing a job is defined as a result of these analyses, it is thoroughly learned so that the best routine becomes natural and inefficient elements are not unconsciously introduced.

The foregoing gives only a general idea of some of the principles and methods of attack in work simplification. In some types of work it is most profitable to analyse the operations of the worker; in others, such as harvesting or feed-mixing, greater insight may be gained by analysing the processes and movements which materials undergo.

Planning and scheduling

Much wasting of time and effort can be saved if work to be done is planned and organized ahead. Jobs need to be arranged according to priorities, in logical sequence and according to the facilities and circumstances demanded, or the farmer will be like A. A. Milne's shipwrecked sailor who could not decide what to do first and ultimately achieved nothing. Jobs should be planned for each day to minimize travel and duplication of work. They should also be planned on a longer term so that seasonal work is prepared for and the peaks and valleys of agricultural activity are smoothed out. The adoption of work simplification enables each job to be performed in an allotted time so that planning and scheduling of work become much simpler and more exact.

Scope for work simplification in agriculture

It is no doubt true that the productivity of each person engaged in agricultural activities has increased tremendously. In the United States of America, for example, in the period 1919 to 1944, farm output increased by 32 per cent, with 12 per cent. fewer farm workers. Dan M. Braum, of U.S. Department of Agriculture, has ascribed about half of this increase in output per worker to improved power and equipment and half to increased yields resulting from better crop varieties, more fertilizers and improved husbandry. Planning and simplification of work have so far contributed little. Although systematic work simplification was undertaken in Europe during the twenties this was mostly limited to certain repetitive jobs on row crops and it is only since 1942 that a general attack on the problems of farm work has been made in the U.S.A. R. M. Carter, at the University of Vermont, was one of the pioneers in studies of work on dairy farms.

Generally speaking it could be said that agricultural operations are conducted no more effectively than operations in industry. Experience has shown that many operations in industry are capable of being improved by up to 100 per cent. by the use of the common sense approach we have discussed. Surely we could anticipate similar possibilities in agricultural activity. A random sample of achievements in the U.S.A. may be quoted as evidence.

(1) The cutting of seed potatoes was studied at Colorado State College and the laws of motion economy applied. From the observations a special knife was designed which, together with simplified motions, doubled the output of older hand methods and gave a 25 per cent. increase over the rotated, disinfected disc cutters. Better control of fungus diseases resulted and it has been estimated that general application of the method could result in

labour saving worth $100,000 in the State of Colorado alone.

(2) In Florida the harvesting of celery from the standing plant to the packed shipping crate was studied. With the same labour force, hours of work and equipment, output was increased 41 per cent. in the first week of operation of a new method. This later rose to 50 per cent. after improvements were made to the packing tables.

(3) A study was made of a dairyman tending 22 cows. After methods improvement and simplification, savings of 2 hours of time and 2 miles of walking per day were made at a cost of less than $50 for equipment. On another dairy farm, methods improvement and a cash outlay of $75 reduced time for essential daily jobs from 124 to 91 days per year and travel from 376 to 238 miles per year. Yet both these farmers were originally more efficient than average.

(4) Detailed process charts and time study were used to re-arrange a colony of 16 farrow-houses. The re-arrangement reduced travel by two-thirds, time by about one-half, and the climbing of 42 fences at each feeding was eliminated.

There is obviously great scope in Australia for analysis and rationalization of work in shearing, milking, feeding pigs and calves and harvesting of all types of crops from grass hay to grapes. Simplified methods can be specifically defined not only in completely repetitive jobs but also where there is either a basic pattern of work upon which variable operations are imposed or where there are repetitive elements in a variable framework. Furthermore, even where there seems to be no pattern or repetition in work, a person trained to think in terms of work simplification makes his own economies of time and effort as he goes along.

The development of a consciousness of work simplification enables work to be done without fatigue, delay and exasperation and frees the mind from preoccupation with trifling hindrances to think critically and constructively about the job in hand. In its overall effect it makes available extra time for occupations which would otherwise be neglected, for maintenance, for better husbandry and production of better quality products, for planning, self-education, thinking and leisure.

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SEASONAL FORECASTING IN AUSTRALIA— CORRELATION METHOD AND GENERAL PROBLEMS

By H. M. TRELOAR

Introduction

Necessary co-operation by agricultural experts

The dependence of primary production on weather ensures the keen interest of agriculturists in seasonal weather forecasting research. Indeed, agriculturists themselves should make a significant contribution in this field by investigating what forecasts would be practically useful in operations. Such a task, of greater difficulty than at first apparent, can now be approached more realistically, because an essential requirement, the specification of maximum forecast performance, can be furnished. This specification applies to the correlation method of forecasting, but until this year, that has been the only system which has received official and scientific recognition, for example, as in India where forecasts covering periods of a few months for different divisions of the country, have been issued by the Meteorological Department for the last thirty years.

Selection and definition of investigation

This article presents the position of investigations on the status, usefulness and application to Australia of this correlation method of seasonal forecasting. Scientific opinion is divided regarding the first two aspects. The work has been carried out in a seasonal forecasting unit in the Department of Meteorology, Melbourne University, with finance from the Commonwealth Government which has also provided an official meteorologist of long weather experience as leader of the group. The explanation of why forecasting each year for specific calendar months, rather than the seemingly more valuable prediction of long droughts or their cessation, has been made the first objective of research, is that little headway has been made in drought studies compared with that in shorter range forecasting.

Outline of treatment

Later in this article an Australian illustration will be given of the kind of relation on which correlation forecasts are based, with an explanation of how they are made. This will be followed by a discussion, in the direct form of question and answer, of the major issues involved in correlation forecasting. First, however, two wider aspects of seasonal forecasting are examined to enable a better appreciation of the general subject to be gained.

Probable limits of seasonal forecasts from general reasoning

Probable conclusions as to the methods available for seasonal forecasting research and the limits of the forecasts which may possibly be attained, can be derived from a consideration of the nature and history of ordinary daily forecasting. It is well known that earlier more general daily weather forecasts were almost wholly based on classification of isobaric charts. It is not so well known that the

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more detailed modern forecasts, especially those for aviation, could hardly be made, if it were not for the great advances of the last thirty years in the knowledge of the physical processes of day to day weather, together with the availability of a great volume of surface observations and considerable numbers of upper air reports made daily or more frequently. In contrast, apart from mean seasonal conditions, little is known of the physical connections between weather of periods more than a few days apart. Further, even surface observations have lengths of records that are rather short for purposes of seasonal forecasting investigation, while upper air records are scanty and recent. Thus to sum up, it is to be expected that seasonal forecasts at most can only give broad and not close specifications of rain, and that they are likely to be wrong in a proportion of years. Further reflection suggests that without a substantial knowledge of the physical processes at work, methods of investigation must be mainly statistical. To the experienced, this also means that they must be critically statistical if wrong conclusions are to be avoided.

It is in the Northern hemisphere that more physical reasoning may be employed in the attack on seasonal forecasting, owing to the greater availability of suitable surface and upper air data and also due to the several years' study of forecasting for extended periods up to several days ahead.

Comparison of significance of descriptive and fundamental methods of attack

In the course of investigations in the past, there has been secured a fair amount of background information of a synoptic nature. Thus Dutch and Australian workers have shown that if in winter pressure is high over the continent, and easterly winds to the north are strong and cold, the following summer rain in Northern Australia and parts of Indonesia is likely to be below average. The reverse also holds. Such illustrations could be multiplied. However from results gained in the work of the Melbourne unit it would appear that the accumulation of such connections will not intrinsically advance seasonal forecasting investigations. Whether or not fundamental researches into the mechanism of the weather, as contrasted with the above descriptive associations, will lead to substantial practical advances in seasonal forecasting remains to be seen. Such fundamental investigations at present are, for example, concerned with solar radiation, its distribution and effect on weather, and with latitudinal exchanges of various forms of energy. If the statistical approach fails, then such studies offer the best prospect of success, but considerable additions to knowledge from many sources would appear necessary, and probably some ten or twenty years would elapse before such a stage was reached. Nevertheless losses of £50,000,000 in some great Australian droughts justify long period research.

Illustration of correlation method of forecasting

What is the kind of relation on which correlation forecasts are based, and how are they made? This information can be obtained by a consideration of Figure 1, which shows the connection, discovered by Quayle in 1928, between Darwin June-July pressure and the subsequent August-September rain over the northern and north western Victoria wheat areas. It will be seen that the rain varies oppositely to the pressure, that for a particular pressure the rain is fairly well defined within a range of 3 inches, and that the expected ranges differ considerably from one another. Thus for a very low pressure the rainfall is likely to be between 4 and 7 inches; for very high pressure between 1 and 4 inches. The chances of expected rain are defined by the lines on the chart, drawn in by correlation theory. Forecasts are usually issued on a 4 to 1 chance; thus

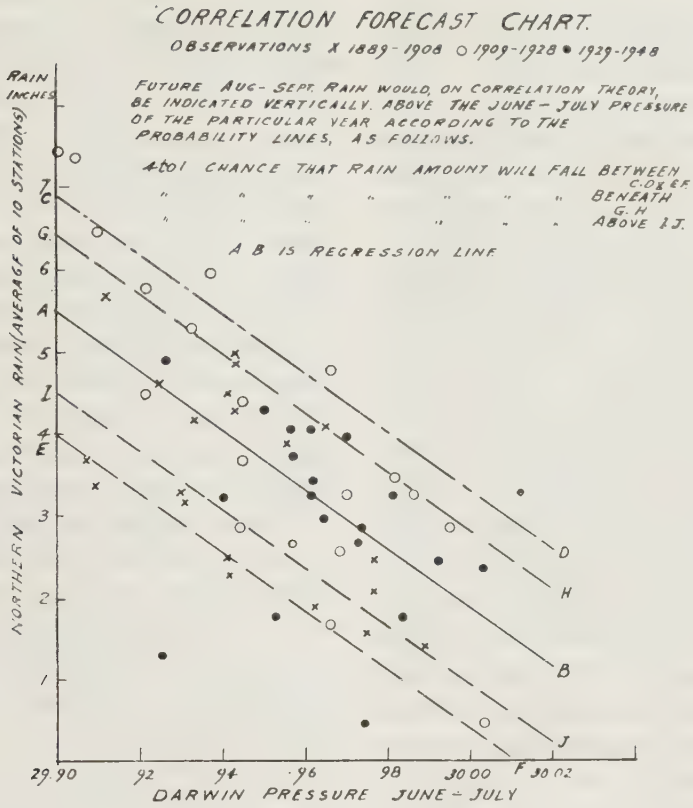
CORRELATION FORECAST CHART.
OBSERVATIONS X 1889-1908 ○ 1909-1928 • 1929-1948
FUTURE AUG-SEPT. RAIN WOULD, ON CORRELATION THEORY, BE INDICATED VERTICALLY ABOVE THE JUNE-JULY PRESSURE OF THE PARTICULAR YEAR ACCORDING TO THE PROBABILITY LINES, AS FOLLOWS.
4 to 1 CHANCE THAT RAIN AMOUNT WILL FALL BETWEEN C.D & E.F
" " " " " " " BENEATH G.H
" " " " " " " ABOVE I.J.
A B IS REGRESSION LINE
RAIN INCHES
NORTHERN VICTORIAN RAIN (AVERAGE OF 10 STATIONS)
D
H
B
J
29.90
92
94
96
98
30.00
30.02
DARWIN PRESSURE JUNE-JULY

Figure 1.

if June-July pressures were 29.92 there would be a 4/1 chance that the rain would be above 3.9 inches (using the line I J); if it were 29.97 there would be a 4/1 chance that the rain total would be below 3.9 inches using the line G H. Similarly ranges of rain, besides upper or lower limits, could be forecast not only for 4/1 chances, but for selected chances to suit special requirements. It will be noticed from the record of rain since 1928 shown on the graph by special symbols, that had such forecasts of lower limits of rainfall been made, they would have been correct on 18 out of 22 occasions, and there would have been much the same result for forecasts of upper limits or ranges of rainfall. The strength of this relation is technically defined by the correlation between the values of pressure and rain, which here is 0.63.

Expected persistence of forecasting relations

What is the position regarding expected persistence of such discovered relations on which, of course, the success of future forecasts depends? First the persistence cannot be guaranteed, because it is known from statistical mathematics that with a correlation of about 0.63, only four-tenths of the causes of the variation of rainfall have been accounted for. Therefore information of the likelihood of persistence is generally sought from the performance of the relation since its discovery; a long

persistence after discovery arguing the probability of further persistence. Unfortunately these after periods are so far relatively short, and the apparent successful result of 18 out of 22 successive forecasts is deceptive, for a reason which warrants careful attention. Most of the predictions of rainfall since 1928 would have been for middle ranges of rain, but such predictions would have been little different from the known 4/1 expectation of rain from the past statistics of rain; so that on these occasions no advantage could have accrued from the forecast. The predictions for higher and lower rainfalls would have been few, and about 3/6 of them correct. Obviously, however, they afford too few examples on which to base any strong expectation of future persistence. There are technical grounds for not basing strong expectation of persistence on the strength of the relation in the years before discovery. One reason is that the relation is generally selected as the best amongst several; another is that there is some irregular periodicity in the rainfall and pressure. On both these counts the relation selected is likely to be lower in the future. Various technical tests have also been applied, with much the same results indicated above. The position, now, is that persistence at the level of the past relation cannot be guaranteed, although persistence at a lower level is likely, but how much lower cannot be assessed. The user of any of such relations would therefore take the risk of poorer performance; on the other hand the information from predictions of extreme years might well prove significantly better than the expected 4/1 chance from past statistics.

Improvement of correlation forecasts

Can correlation relations be improved? This has been the major object of seasonal forecasting research for a number of years. The object has been to find additional indicators of future rain, and combine their effects in one forecasting formula. The strength of the relation is then measured by a multiple correlation coefficient. All the Indian forecasts are of this kind, and some have been formulated for Australian districts. The Melbourne unit had sought widely for such additional indicators, using pressures, temperatures, positions of meteorological centres of action, great wind streams and other elements. Unfortunately it has been discovered in the unit that forecasts cannot be improved in this way. Summarily, this is because the partial correlations of secondary indicators, arrived at by eliminating the joint effect of the primary indicator, do not reach statistical significance and if they do they add little to the effectiveness of the formula*.

Maximum expected performance of forecasts

What is the highest correlation or relation to be expected by this method of forecasting? The answer is that a relation of about 0.6 correlation is as high as can be expected. A relation of such strength is that of Figure 1. The reason for this statement is that primary indicators are practically alone effective, and this is about their upper limit.

In what areas in Australia might correlation forecast relations be found? The

*A mathematical statistical paper on this and other aspects of seasonal forecasting will be published shortly by Miss A. Grant, M. Sc., of this Unit.

magnitudes of the primary correlations of many indicators with rain in various parts of the continent indicate that it is only in some districts and in some months in northern, eastern inland and inland south eastern Australia that correlation relations of significant strength are likely to be discovered. The unit will probably determine these in the next year. Already some have been published by workers for areas in northern Australia and eastern Queensland, and the unit has found the relation shown in Figure I extends not only to central north, and north western Victoria, but also embraces north eastern Victoria, Riverina, the adjacent slopes, and eastern highland country.

Usefulness of forecasts of maximum specified performance

Are correlation forecasts of the above specified maximum economically useful? It is thought that considerable examination of this problem is necessary by practical experts before decisions can be reached. Losses as well as gains from following the forecasts must be taken into account.

The factors involved are so complex that each application is a special problem. This is illustrated by the decisions of both a hydro-electric and an irrigation authority that such forecasts would not be economically useful. This conclusion was not based on the absence of average advantages over a long period, but on the vital disadvantages which sometimes would occur when the forecasts were incorrect, resulting in the one case in a serious depletion of emergency current and in the other of irrigation water supply. The need for specialized examination seems clear. For this reason the States have been requested to have the issue investigated by departments and authorities concerned with primary production and water problems. Such examination has already commenced and should furnish much valuable information of importance to agriculturists.

The assessment of the usefulness of seasonal forecasts of specified performance is less difficult in classes of operations, where there is a direct water use obviously related to the forecasted and actual rain, as in the examples quoted before. Where, as in agriculture, the effect of the rain in the period forecast is obscure, the problem is very complex. Beneath, a method of approach is suggested in a particular case, but it is fully realized that only practical experts can make a satisfactory examination and derive reasonably reliable conclusions. A department of agriculture has advised that forecasts of the break of the season for wheat sowing would be highly valuable. The problem is whether a measure can be obtained of the losses and gains occurring from following such a forecast. Suppose from experiment there was known for each of many years the relation: wheat yield—date of sowing and that this was representative for the district. If it were not representative a relation would have to be obtained and taken count of in the investigation. For each year there would be available the date of optimum sowing, and the loss of yield for that year for sowing at any other date. In addition the loss of yield in the district owing to sowings not all being made on the optimum date (LA) would be known for each year.

If now a forecasted date of sowing were available the losses (LF) owing to sowing on this date and not on the optimum

date would be known for each year. The comparison for each year of (LA) average loss in district practice and (LF) loss from following the forecast would determine the utility of the forecast. A forecasted date might be obtained after research from the relation of the kind shown (Figure 1) between an indicator and the optimum dates of sowing. The relation would give the forecasted optimum date for any year and also the 4/1 or other chance that the optimum date would fall within a period of so many days. The forecasted optimum date would not generally be the actual optimum date, unless the correlation of indicator and optimum dates were perfect (correlation = 1.0). The practicability and significance of such or similar investigations is a matter for agricultural experts, but it would seem difficult to know how useful forecasts would be without special enquiry.

Further projected work of the seasonal forecast unit

In the future work of the Unit endeavour will be made to complete within a year the determination of correlation forecast relations, which might approach the level of usefulness. There are other projects on hand, one of which is the examination with the use of upper air data of two summers in which there were big rain contrasts in central eastern Australia. A study will be made of a recent method of seasonal forecasting evolved in America, in which forecasts are made a month ahead of rain in three grades of intensity. Use is made in this latter method of surface and upper air data for much of the Northern Hemisphere, and it may be that the absence of such data here would preclude application of the system. Later investigation of droughts will be commenced.

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SOME RAINFALL CHARACTERISTICS AT TRANGIE AGRICULTURAL EXPERIMENT STATION

By E. G. CUTHBERTSON

Introduction

Trangie Agricultural Experiment Station is located approximately 250 miles northwest of Sydney in the Central Western Slopes Division of New South Wales. Situated at an elevation of 700 feet, the Experiment Station lies on a weakly undulating peneplain between the Bogan and Macquarie rivers. The topography is typical of a large area of the "Western Plains".

This analysis is based on 33 years of records of rainfall measurements for the 24-hour period ending at 9 a.m. each day. Measurements were made with an 8-inch rain gauge erected under standard conditions; the rim of the funnel was 1 foot above the ground. The site of the climatological station is approximately the centre of a cleared area some 2,000 acres in extent. The closest obstruction, disregarding fence lines, are buildings some 150 yards to the north.

Monthly and seasonal rainfall

The mean annual rainfall of 16.53 inches is received in 55 days. Seasonally, the winter period—April to September—receives 7.84 inches in 30 rain days and the summer period—October to March—8.67 inches in 25 rain days. Generally there is little variation from season to season although there is a maximum in winter and a minimum in autumn. However, marked variability occurs in the six-monthly rainfall registrations April to September and October to March. Using the standard deviation expressed as a percentage of the mean, as a measure of rainfall reliability, the April-September and the October-March periods show a 14 per cent. and a 42 per cent. variability respectively. Seasonal rainfall expectancy calculated for these periods is shown in Table I.

TABLE I

Rainfall Expectancy at Trangie Agricultural Experiment Station.

Probability	Expected Rainfall in Inches	
	April-September Mean 7.84	October-March Mean 8.67
Once in 20 years greater than	9.74	15.79
Once in 20 years less than	5.64	1.53
Once in 10 years greater than	9.41	14.63
Once in 10 years less than	5.97	2.69
Once in 5 years greater than	9.03	13.32
Once in 5 years less than	6.35	4.00

Rainfall per day of rain

Table II shows the proportion of the seasonal rainfall falling at different rates. Half the winter and spring rain is received in daily falls of less than 0.5 inches; four-fifths in daily falls of less

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than 1 inch. At the higher rates, however, the percentage of rain received from falls in excess of 1 inch in summer and autumn is double that of winter and spring.

TABLE II

Rain per day by seasons expressed as percentages of seasonal rainfall.

Daily Rate in Inches	Spring	Summer	Autumn	Winter
	%	%	%	%
0.01-0.10	8.2	5.6	5.2	10.6
0.11-0.20	12.7	8.2	7.7	10.8
0.21-0.50	29.1	21.2	16.5	28.3
0.51-1.00	31.8	29.1	32.1	29.0
over 1.00	18.2	35.9	38.5	21.3

Daily maximum expectancies have been calculated for each of the seasons. Figure 1 shows the curves obtained with the daily rate plotted along the ordinate and the expectancy, in years, logarithmically, along the abscissa. Seasonal variation in the expected maximum daily fall can best be illustrated by comparing the chances of receiving 1.50 inches or more in one day. In summer this amount will be received on the average once in each season; in autumn once in every second season; in winter once every $3\frac{1}{4}$ years, and in spring once every $4\frac{1}{4}$ years. A daily fall of 230 points or more may be expected once in every third summer but such a fall would be expected during the winter period only once in every 25 years.

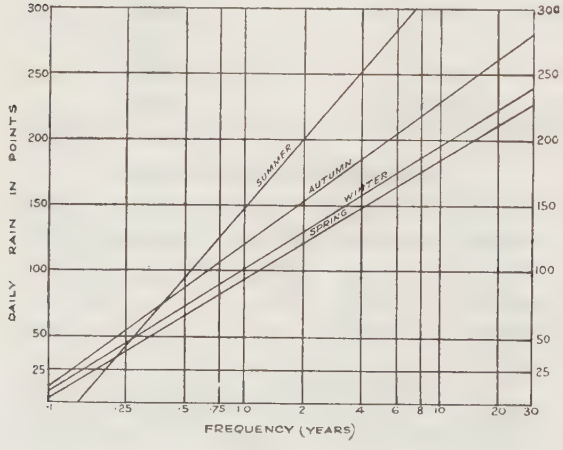

Figure 1.
Seasonal frequency of maximum daily rainfall

These figures suggest that the period of highest intensities is the summer period.

Periods of absolute drought

There is much variation in the use of term "absolute drought". In England absolute drought is recognized as a period of 15 or more consecutive days without measurable precipitation (Lewis, 1939). In the United States, however, length of rainless periods is often calculated with complete disregard for registrations of less than 0.1 inches in 48 hours (Thornthwaite, 1941). Wood (1936) concludes that, for conditions operating at Koonamore in South Australia, rainfall registrations of less than 0.2 inches are not effective in time of drought. Smaller registrations may be effective if they follow previously effective rains.

It was decided to use Thornthwaite's method (*loc cit.*) as the most suitable for the present analysis, although disregarding small registrations after recent heavier rains has serious objections.

Annual and seasonal expectancies of rainless periods are shown in Figure 2. A comparison of calculated and actual rain-free periods showed no significant differences at the 1 per cent. level. An exponential relationship between frequency and duration of drought is suggested by the type of curves obtained. However, Blumenstock (1939) has shown that, since it would be impossible to obtain an annual expectancy of a rainless period greater than 365 days, these curves would become asymptotic to the X-axis if the period for which rainfall data were available was of sufficient duration.

A rain-free period of 45 consecutive days can occur every year and one of 60 consecutive days, on the average, once in every $2\frac{1}{2}$ years. However, on a seasonal basis such periods would be expected once in each season only every fourth and tenth year respectively.

Periods without effective rainfall are longest in autumn, intermediate in the spring and summer and shortest in the winter. The differences are of extremely small magnitude when one considers the length of the individual rainless periods —only 4 days' difference between autumn and winter in the length of a rainless period experienced once in 30 years. Rainless periods of 25 consecutive days can be expected once in every season while a rainless period of 60 consecutive days' duration can be expected in each season once in every 10 years. Protracted rainless periods are thus of common occurrence.

Rainfall characteristic and erosion

There is an erosion risk in all seasons at Trangie.

Water Erosion

The risk of water erosion during the winter and spring is low because a large proportion of the rain is received in daily falls of less than 0.5 inches and because of the generally level nature of the country. The risk is greater during the summer and autumn. The frequency of occurrence of days with rain in excess of 1 inch is greatest in the autumn and this period is likely to be the time of greatest soil wash; the summer period will be only slightly less susceptible to soil washing.

Wind Erosion

Protracted dry periods in all seasons will provide a ready source of dust. The period of greatest wind erosion is probably spring and early summer, when strong winds are most common.

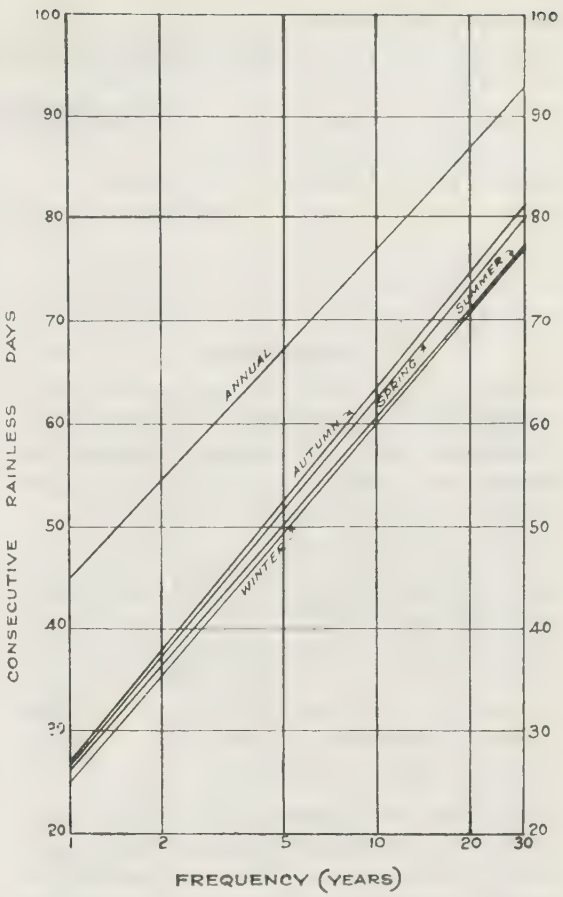

Figure 2.
Annual and seasonal frequency of rain-free periods of specified length.

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A NEW SYSTEM OF SOIL CLASSIFICATION

By A. KARIM

Introduction

The study of soils in one way or another has interested man from time immemorial; but, it was only during the nineteenth century that such studies developed into a branch of science.

An examination of the early literature on soils clearly reveals the widely diverse concepts held regarding the meaning of the term "soil". This influenced both the nomenclature and classification of soils, as may be seen from the works of Glinka (1914), Robinson (1949), Lee (1928), Yarilov (1901) and others.

Because soils were handled by man centuries before the birth of pedology in the Russian School, they became known mainly through the senses of sight and touch. Consequently soil names arose based sometimes on colour, sometimes on texture, and sometimes even on the nature of the crop grown. These haphazardly developed soil names are still present in the literature thereby creating confusion and error.

As the new science of pedology spread beyond Russia, many Russian soil names were adopted by different countries and these names added to other soil names of more local origin. Thus the difficulty of developing any reasonably logical system of soil classification for general or universal application was increased. Further, it is well nigh impossible to come across exactly the same soil in all details in the various parts of the world, or even in one particular area. This means that any attempt to adopt names like Podzol, Chernozem, Rendzina, Terra Rossa and so forth for universal application is too far from scientific discipline. Again, such soil names have little, if any, pedological meaning. Yet all systems of soil classification proposed to date have this kind of terminology. The implications of this have been discussed by Prescott (1935), Brade-Birks (1931) and Crowther (1935).

Former systems of classification

Pedologists are aware of the gradual evolution of the different systems before and since the Dokuchaievian period. Interested readers may refer to Glinka (1914). More recently various systems have been proposed by Marbut (1935), Baldwin, Kellogg and Thorp (1938), Robinson (1949) and Stephens (1950). To this may be added the work due to Hallsworth and Costin (1950).

Marbut's (*loc. cit.*) attempt at classifying soils on the basis of their profile morphology into two main orders, namely, pedalfers and pedocals, seems to be the most logical approach yet made to soil systematics. Unfortunately, his system does not provide for the large number of soils having both alferic and calic properties. The Prairie soils, some of which Marbutt recognised as akin to rendzina, were grouped under the pedalfers. Further, Category III of his system seems to be self-contradictory. Also, the terms

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designating the soil groups are not scientific.

The Baldwin, Kellogg and Thorp (*loc. cit.*) system which is largely followed in America at present, was meant to be an improvement on Marbut's system. This system, although supposedly based on soil characteristics, has very little appeal for the author. Thorp and Baldwin (1938) tried hard to justify the system in such a way as to occasion surprise regarding their concepts of "Soil Characteristics" and "Fundamentals of a Scientific Classification".

Robinson's (1949) system, seems quite encouraging in some respects but unfortunately it starts with the kind of water movement within the profile as the criterion of classification in the highest category; and, seems to contradict Robinson (*loc. cit.*) himself regarding the fundamentals of soil classification.

In the midst of all this chaos and confusion, Stephens (1950) proposed a system which, stimulated by the basic principles of Marbut's classification, clearly sets forth the orders and sub-orders with real logic and sense behind the approach. Unfortunately, this classification does not provide for soils showing both alferic and calic features. However, Stephens left a gap in his Category VI without making any unorthodox or arbitrary grouping. Stephens' sub-orders, Category V, have been discussed and criticised by Hallsworth and Costin (1950). The author of this paper has nothing to add to their criticism at the sub-order level. At the great soil group level, Category IV, it is considered to be unfortunate that the terms used are not scientific.

It seems to be quite clear that the two astounding deadlocks in soil systematics today are:

(1) the need for precise and scientific terminologies to designate the different soil groups of the world, and

(2) the need of a system of classification of a sufficiently philosophical approach to command international recognition.

The present work was undertaken to suggest some solution to the above crisis by proposing a new kind of soil nomenclature and classification.

Proposed new system of classification

It must be clearly borne in mind that the fundamental principle of any system of classification is to provide the most logical ordering of the objects to be classified, as we see them, so as to give us the greatest possible command over knowledge already acquired and lead most readily to the collection of further knowledge.

Orders and Sub-orders

As stated before the author accepts the philosophy of Marbut (*loc. cit.*) which makes the primary separation of soils on the basis of calcimorphism and alferomorphism. But it is to be remembered that soil science today embraces wide areas of soils in various parts of the world showing both the above properties in the same profile. Surely, there can be no justification for leaving such soils as transitional, or arbitrarily grouping them with either the calic or alferic soil orders. It is hereby proposed that a new order be introduced and named *Pedocalo-Pedalfer* which may be conveniently shortened to *Pedocal-alfer*.

For the sub-orders, it would seem that the wisest policy would be to maintain, if possible, uniform terminology, and yet, one expressive enough to give a clear insight into the kinds of soil profiles included.

Experience shows that alferic, that is, sesquioxidic soil properties may be found

either in the *B* or *A* horizons of the soil profile. Therefore, the sub-orders under the order pedalfer may be termed *Epi-alfer* and *Hypo-alfer* respectively. All soil profiles having an accumulation of sesquioxides in the *A* horizons are epi-alferic soils, and those with an accumulation in the *B* horizons are hypo-alferic soils.

As far as the pedocals are concerned, the information available to date shows that an accumulation of calcareous material occurs only in the sub-soil horizons. Therefore, the sub-order under the order pedocal may be termed *Hypo-cal.*

The above proposition may be arranged in tabular form as follows:—

Order	*Sub-order*
Pedalfer	Epi-alfer
	Hypo-alfer
Pedocal-alfer	Epi-calalfer
	Hypo-calalfer
	Epi-alfer-hypo-cal
	Hypo-alfer-epi-cal
Pedocal	Epi-cal
	Hypo-cal

The sub-orders are shown in all the possible combinations to provide for soils of unknown as well as known characteristics.

Soil Group names

As discussed previously the different soil names used in different countries cannot be regarded as having international standing. It seems appropriate therefore to introduce names which would give a more precise meaning to the groups and maintain at the same time uniformity of nomenclature. In the author's opinion the way to do this is to tie up the sub-order terminologies with the kind of genesis of particular soil groups. By so doing, it is possible to create a binomial nomenclature at the present great soil group level. From a study of soil profiles it seems that there are three main kinds of profile genesis, namely (1) autogenesis; (2) halogenesis, and (3) hydrogenesis. For example, by using this method a podzol of Russia could be redefined as a Hypo-alfer autogenii, similarly, Robinson's (*loc. cit.*) ferralites become Epi-alfer autogenii. A solod soil which is often difficult to distinguish from a podzol may be classed as Hypo-alfer halogenii. Again, the rendzina of Poland which is akin to the regur or black cotton soils of India, may be classed as Hypo-cal autogenii. If the rendzina shows distinctive hydromorphic features such as occur in Stephens' (*loc. cit.*) water-table rendzinas, then they can be defined as Hypo-cal hydrogenii. In this way all the various soil groups both known and unknown may be classified satisfactorily and placed in the system under discussion. The author is aware that the binomial system of naming sounds rather awkward but feels that this is not sufficient reason to sacrifice the precision thus gained.

The system as visualized by the author is demonstrated in Table I.

It may be argued that the group names are entirely different from those known today in various parts of the world. But that should not matter as the system presented here may be likened to the existing system of botanical classification. For example, the plant named *Oryza sativa* by a systematic botanist, is rice to an English farmer or "chaul" to a Pakistani farmer. Hence the binomial system of nomenclature at the soil group level should not give any trouble to a pedologist.

The author feels that categories below the group level should be left open for soil workers in different countries to make classifications to suit local needs, as

TABLE I

A new system of soil classification

Order	*Sub-order*	*Group*
Pedalfer	Epialfer	Epialfer autogenii Epialfer halogenii Epialfer hydrogenii
	Hypoalfer	Hypoalfer autogenii Hypoalfer halogenii Hypoalfer hydrogenii
Pedocalo-Pedalfer or Pedocal-alfer	Epical-alfer	Epical-alfer autogenii Epical-alfer halogenii Epical-alfer hydrogenii
	Hypocal-alfer	Hypocalalfer autogenii Hypocalalfer halogenii Hypocalalfer hydrogenii
	Epialfer hypocal	Epialferhypocal autogenii Epialferhypocal halogenii Epialferhypocal hydrogenii
	Hypoalfer epical	Hypoalfer-epical autogenii Hypoalfer-epical halogenii Hypoalfer-epical hydrogenii
Pedocal	Epical	Epical autogenii Epical halogenii Epical hydrogenii
	Hypocal	Hypocal autogenii Hypocal halogenii Hypocal hydrogenii

long as liaison is maintained between local soil names and the system presented here. When this is done, then the system under discussion will prove a satisfactory and scientific means of correlating soil classification at an international level.

Before closing it seems desirable to point out that the proposed system is formulated to accommodate only those soils showing genetic profile development.

The author proposes to draw the particular attention of his colleagues to the fact that shyness and conservatism have no place in the domain of science, if science is to advance as it should. Soil systematics has had enough of vagueness and lack of discipline. It is high time indeed that soil scientists gave serious thought to the real meaning of scientific discipline, otherwise the very foundations of the science of pedology may be shaken.

Acknowledgments

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PLANT QUARANTINE SURVEY IN THE NORTHERN TERRITORY

By J. V. MERTIN

Summary

Towards the end of 1950, a survey of some established exotic plant diseases and insects and a search for possible new-comers, was made in the Northern Territory.

In an extensive search for Citrus Canker, no evidence of its presence amongst 4,400 citrus trees was found. This serious disease, although found as early as 1912 in the Northern Territory, was not eradicated until 1922. Reasons are advanced for the belief that the Northern Territory is still free from this disease.

Some light has been thrown on the occurrence of fruit flies. The main species obtained both by breeding from infected fruits and by netting, was *Afrodacus jarvisi*, Tryon. The widespread occurrence of this species in relation to the distribution of host plants is discussed. The danger of exporting fruit fly-infested fruits by air to the other Australian States, especially to South Australia, the only remaining fruit fly-free State, is emphasized.

No definite evidence of the presence of rice diseases was established, but *Pyralid* larvae were found infesting rice stems at Katherine.

Indian Milkweed, *Calotropis procera*, (Willd.) R. Br., was the most important weed found. This plant, which is becoming firmly established in the Upper Roper River Valley, probably entered the Northern Territory from Queensland. The vegetation adjacent to the landing strips at the Darwin airport was carefully searched for exotic plants considered capable of assuming noxious proportions. None was found.

Specimens of Pink Bollworm, *Pectinophora gossypiella*, Saund., were collected. A previously unknown species of *Pectinophora* was discovered at Katherine. Other minor cotton pests were found.

Introduction

During November and December, 1950, in the Northern Territory, field investigations into matters of importance to plant quarantine administration were conducted. There were two main reasons for the survey:—

(1) To search for certain plant diseases, insects and weeds not yet considered to be established in Australia, but which could gain a foothold in the North if given the right opportunities.

(2) To establish the presence (or absence) and the distribution of other exotic diseases and pests which entered the Northern Territory many years ago.

In this regard, it is now possible to make a statement on Citrus Canker, certain fruit flies, rice diseases, weeds and cotton pests.

The introduction of field surveys into the activities of the Division of Plant Quarantine represents a new development of some consequence. Detecting and mapping the distribution of diseases, pests and weeds are essential pre-requisites both for inaugurating eradication campaigns and for reviewing intelligently the quarantine legislation affecting the regions.

Nicholson *et al* (1941) and Annand (1947) have stressed the need and importance of these surveys. The former have also emphasized the necessity for quarantine personnel to travel freely. In this regard, every facility was made available to the author during the Northern Territory survey. Various Commonwealth Government Departments, religious organizations and private individuals in the Northern Territory, all gave splendid co-operation and generous assistance. As a result, in approximately one month, it was possible to

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travel nearly 5,500 miles by aircraft, launch and truck.

Citrus Canker

A short review of the history of Citrus Canker and its eradication in Australia, will reveal the reason for searching for evidence of this disease.

This bacterial disease which is caused by *Xanthomonas citri*, Hasse, is highly infectious and probably had its origin in the Orient. Hill (1918) first examined diseased lime and lemon trees at Stapleton, 70 miles South of Darwin in 1912 without knowing the responsible organism. In the Port Darwin area, heavily infected trees were also found. Not until 1915 was the identity of the organism published in America. Between June, 1915, and September, 1916, three Commonwealth Proclamations were issued which separately prohibited citrus tree imports into Australia, citrus fruit imports into Australia and the removal of citrus trees and fruits from the Northern Territory to any other part of Australia.

In 1918, Hill officially surveyed the occurrence and distribution of the disease in the Territory. Later in that year, the following places, all of which contained infected trees, were quarantined for five years—Darwin, Stapleton, Oenpelli Aboriginal Mission Station, Daly River Settlement and Port Charles Lighthouse Reserve. At these localities, all citrus trees were destroyed by fire.

The Administrator of the Northern Territory (1918-1930) has reported that the initial eradication campaign did not achieve the desired result. It therefore became necessary for Hill to make another extensive survey in 1922, and consequent to finding new outbreaks, he recommended that *all* citrus trees in the Northern Territory be destroyed. However, the destruction campaign was modified in that all trees north of the nineteenth parallel were the only ones which were dug out and burnt. At outlying cattle stations, mounted policemen supervised the destruction of trees.

It was not until 1925 that permission was granted to permit the growing of citrus trees again. Plantings were rigidly inspected, but re-infection of the trees was not found. The last mention of Citrus Canker inspection is found in the Administrator's Report for the Northern Territory for 1930.

Hill believes that the disease was introduced directly into Darwin from China or Japan on trees or fruits or both. Although cankerous growths were first seen at Stapleton in 1912, Hill found that diseased trees had been distributed from the Botanic Gardens in Darwin several years earlier.

In 1950, it was possible to visit almost all the regions which featured in the original surveys of 1918 and 1922, as well as several new citrus areas. Altogether, citrus totalling 4,400 trees in orchards and home gardens were examined without finding any trace of Citrus Canker symptoms. Of these trees, 1,650 were distributed between Darwin and Katherine, and on Melville and Bathurst Islands. The remainder were growing in and near Alice Springs. In more detail, trees were inspected in the Upper Northern Territory at Darwin, Berrimah, Winnellie, Night Cliffs, West Point, Koolpinyah, Stapleton, Adelaide River, Fountain Head Mine, Pine Creek, Katherine and the Mission Stations at Oenpelli, Bathurst Island and Melville Island. The latter three were visited in a Commonwealth Department of Health aircraft (see Figure 4).

Because of the limitations of time, the below-mentioned places were not visited. However, searching questions on the presence and the health of citrus trees were sent by radio to the officers in charge of Cape Don Lighthouse and the Mission Stations at Roper River, Groote Eylandt, Croker Island, Milligimbi, Goulbourn Island and Elcho Island. From the answers received, it is considered that Canker is

not infecting trees at the named Mission Stations. Cape Don Lighthouse reported that no citrus trees were growing there. Information was also received that citrus trees were no longer grown at Point Charles Lighthouse.

Although the normal climatic conditions of the Alice Springs region would probably prevent the establishment of the disease there, nevertheless, 2,750 trees were examined (including 1,500 nursery stock) at the following places:—Alice Springs, Yamba Station, Undoolya, Hermannsburg Mission Station and the Native Affairs Settlements at Jay Creek and Yuendumu. The Soft Brown Scale *Coccus hesperidum* L., was found to be well-established on citrus trees in the Alice Springs area.

For the following reasons, the Division of Plant Quarantine believes that Citrus Canker does not exist in the Northern Territory:—

(1) No extensive investigation has been made of this disease since about 1930. Because it is so highly infectious, it is probable that should the organism have developed again between 1930-50, it would have become very widespread. In view of the fact that 4,400 trees were seen, which would represent 95 per cent. or more of the citrus population in the Northern Territory, some diseased trees would have been found if the organism were again present.

(2) The organism is not one likely to be carried over in the soil.

It is interesting to note the effect of present-day travel facilities on field surveys. In 1918, it took Hill two and a half months during the dry season, using horses and train transport, to inspect the trees. In the 1950 survey, the use of aircraft, motor launch and truck permitted a greater area to be covered in a few weeks in the beginning of the wet season.

Fruit Flies

During World War II, the Oriental Fruit Fly, *Dacus dorsalis,* Hendel., was introduced into the Hawaii group of islands. U.S.A. authorities consider it was introduced by military aircraft. Its presence there has created a serious problem and has caused considerable concern in California because of the movement of aircraft between the two places. This fly is a devastating pest and has the ability to breed in fruits and nuts of more than a hundred host plants.

Figure 1.
Mature fruits of the Wild Red Apple, Eugenia suborbicularis.

Bearing in mind that the tremendous use of Service aircraft in the last war could have moved the Oriental Fruit Fly into the North, a search was made for it in the Darwin area. No indications of its presence here were found. Although the number of fruit flies obtained was only about forty, it is likely that had *Dacus dorsalis* been present, specimens of this vigorous colonizer would have been netted or bred from infected fruits.

The specimens collected were *Rioxa termitoxena* Bezzi (from Darwin) and *Afrodacus jarvisi,* Tryon. (from Darwin, Katherine, Oenpelli Mission Station and Koolpinyah). The former insect does not normally attack fruit. Apart from the customary host-plant fruits, such as the mango and pawpaw, *Afrodacus jarvisi* breeds in some native fruits such as *Careya australis,* F. Muell. (*Planchonia careya*), the so-called Pigfruit,

Wild Pear or Billygoat Plum, and *Eugenia suborbicularis,* Benth., the Wild (Red) Apple. Fruits of the latter species (shown in Figure 1) yielded fruit-fly larvae at Darwin, Koolpinyah and Oenpelli Mission Stations. More fruit-fly larvae were taken from fruits of *Careya australis* at Darwin and Katherine.

Perry (private communication) has reported that *Careya australis* extends from the Kimberleys in the West to Townsville in the East, and from Darwin in the North to Katherine in the South, and possibly to Daly Waters. Likewise, *Eugenia suborbicularis* is found mainly around Darwin and into Arnhem Land. In a North-South direction, the species probably extends South from Darwin to Adelaide River and possibly as far South as Pine Creek. He has reported this species to be present in the Kimberleys as well.

May (private communication) has supplied further evidence of the distribution of *Careya australis,* stating that it extends well into Southern Queensland. Related to its distribution there, is the widespread occurrence of *Afrodacus jarvisi.* Although this fruit fly is more numerous in Northern Queensland, it has been recorded from as far South as Stanthorpe where stone fruits and apples are liable to be attacked.

The results of the survey dealing with fruit flies indicate that some fruit flies breed freely in the Upper Northern Territory. It follows that should any Australian States obtain fruit supplies from there, they should recognise the dangers associated with such trade. This particularly applies to South Australia, the remaining state still free from fruit flies and with which regular airline service contact is made.

With respect to Alice Springs, no evidence of fruit flies was found and it can be accepted as a clean area. It is very desirable to preserve this situation. The main fruits grown at Alice Springs are citrus and apricots.

Rice diseases and pests

With the possibility that large-scale rice growing may eventuate in the Northern Territory in the future, it is important that production can proceed under disease-free conditions as in the Southern States. With regard to this, Australia occupies a unique position in that no serious rice diseases exist here. This contributes in no small way to the high yields per acre of rice. Although rice was grown in the Northern Territory many years ago, no diseases have been recorded. Rice plants seen by the author were in the pretillering stage and were all healthy. One piece of old rice straw examined at Adelaide River had lesions resembling those produced by *Helminthosporium,* but careful examination of the material in Adelaide failed to show the presence of an organism.

At Katherine, larvae and pupae of a member of Family *Pyralidae* (Lepidoptera) were collected from stems of wild rice. Those plants which were infested produced only grainless florets. It has been established that these specimens are not *Pyrausta nubilalis,* Hubner, the European Cornborer, another destructive stem pest of crops in North America, Europe and Asia. Quarantine measures have successfully excluded this pest from Australia.

Weeds

Altogether, nearly forty plants were collected which were considered by the author to be potential weeds or which are definitely considered in the Northern Territory to be weeds. None of these proved to be exceptionally dangerous. However, special mention is made of the Indian Milkweed, *Calotropis procera,* (Willd.) R. Br., which is depicted in Figure 2. This is a photograph of a mature plant, six feet in height.

Indian Milkweed is a native of West. Africa and India. It is becoming naturalized in Northern Queensland and it probably entered the Northern Territory from that state. It was first re-

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Figure 2.
Indian Milkweed, Calotropis procera, on the roadside at Katherine.

corded in the Upper Roper River Valley in 1947 from where it is spreading rapidly. It has large fruits measuring six inches in length and four inches in width. These fruits are shown in Figure 3. They contain a great number of plumed seeds and it is highly probable that dissemination by wind is very efficient. Indian Milkweed has reached serious proportions at Mataranka and has spread out North-West to Katherine (where it is present in the flora adjacent to the aerodrome) and to Adelaide River. Webb (1948) has reported that it contains a number of toxic principles including calotropin, a cardiac poison.

The flora adjacent to the landing strips at the Darwin airport was systematically examined for weed populations. Nothing was found to indicate that overseas aircraft were introducing foreign seed to the Darwin airport.

Cotton pests

Cotton culture has been irregularly practised in several places in the Northern Territory for more than the last forty years. During this period, many insects have been associated with this crop in the Territory, especially the Pink Bollworm, *Pectinophora gossypiella*, Saund.

Holdaway (1928) has reported that it was first found there in 1912 in the Roper River area. He also recorded its presence at Broome in Western Australia as early as 1911. In both these States, it has been located at various times on other malvaceous plants as well as on cotton bushes. A related species, *P. scutigera* Hold., has been found only in Queensland.

During the 1950 survey, every opportunity was taken to examine cotton bolls and the fruits of other malvaceous plants for pink larvae. It was hoped that evidence would be forthcoming to throw some light on the distribution of *Pectinophora* and its host plants in the Northern Territory. Common (private communication) has made the following identifications from the specimens submitted:— *P. gossypiella*, Saund. on cotton (Darwin, Lee Point and Stapleton) and also an unknown species of *Pectinophora* found on cotton (Katherine).

Sida spp. are common in the Territory, but not on any occasion were pink larvae found in their fruits.

A number of other cotton pests were collected. At Katherine, larvae of the

Figure 3.
Close-up of the large mature fruits of the Indian Milkweed.

Rough Bollworm *Earias hueglii,* Rogenh., were causing extensive damage to cotton bolls. Hill (1915) reported considerable destruction of cotton by this pest at Batchelor in 1914. The following were also collected in 1950:—the Red Cotton Bug, *Dysdercus cingulatus,* F., on *Sida cordifolia,* L. (Darwin); the Yellow Cotton Bug, *Tectocoris lineola,* Fabr., on cotton (Stapleton); the Black Cotton Seed Bug, *Oxycarenus luctuosus,* Montr., on cotton (Lee Point); and a *Pyroderces* sp. on *Hibiscus rosa-sinensis,* L. (Darwin), *Hibiscus tiliaceus,* L. (Lee Point), and on cotton (Darwin, Lee Point, Stapleton).

At Alice Springs a search of cotton, *Sida rhombifolia var. incana,* L., *Hibiscus farragei,* F. v. M., and *Cienfuegosia australis,* Benth., revealed no trace of pink larvae or typical larval damage.

Acknowledgments

The assistance and guidance given by Dr. T. H. Harrison, Director of Plant Quarantine, in all matters connected with this survey are greatly appreciated. The author also expresses his gratitude to those officers of the following departments and organizations by whose generous help the survey proceeded smoothly and the collected material was identified willingly—the Commonwealth Health Department (N.T. Division), the Department of Civil Aviation, the Northern Territory Administration Branch (Agriculture, Forestry, Native Affairs), Overseas Telecommunications, the R.A.A.F., the United Church Mission and Church of England, Lutheran and Roman Catholic denominations, the C.S.I.R.O. at Katherine and Canberra, the Waite Agricultural Research Institute, the Adelaide University, the Adelaide Museum and the Queensland Department of Agriculture.

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Figure 4.
The Department of Health's "Miles Gemini" aerial ambulance at Bathurst Island Mission Station during the survey.

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MOTTLE LEAF OF TWEED WONDER BEANS

By R. J. CONROY and R. D. WILSON

Summary

A condition occurring in Tweed Wonder beans, particularly in one strain known as "South Coast", and which has been termed "mottle leaf", resembles that described by some overseas workers as variegation and one-sided mosaic, which are hereditary abnormalities. It also bears some resemblance to another described variegation which was considered to be cytoplasmically inherited.

Symptoms to which the name "dwarf mottle" is applied, similar to the severe effects of variegation described by overseas workers, also occur in those lines of Tweed Wonder which show mottle leaf.

The various symptoms of mottle leaf can be masked in the later life of the plant and also may not become evident until the plant is well grown.

The condition has been shown to be seed transmitted but the evidence so far obtained, however, has not elucidated the exact nature of this seed transmission, the problem being complicated by variation in symptom manifestation which is possibly influenced by environmental factors.

Evidence from one small experiment suggests that mottle leaf reduces the seed yield of plants.

The term "mottle leaf" has been applied in New South Wales to a seed-transmitted variegated leaf condition of Tweed Wonder beans (*Phaseolus vulgaris* L.). When the condition first came under observation some five or six years ago it was thought to be a virus disease. However, repeated failure to secure transfer to healthy plants by sap inoculations, combined with the nature of the symptoms, have led to the conclusion that it is almost certainly a non-infectious variegation.

The Tweed Wonder variety was evolved as an anthracnose-resistant selection from Canadian Wonder and was named and released by the New South Wales Department of Agriculture about 1928. It was later found that the variety was particularly suitable for growing under cool conditions and it became established as the main variety for the early spring crop in the Gosford district (seed sown in June and July). Since about 1945 it has been recognized that there are two distinct strains of Tweed Wonder in New South Wales, differing in the percentage of mottle leaf. One strain, often referred to as the "Tenterfield" strain, is practically free from mottle leaf, (number of plants showing symptoms in the field being always well under 1 per cent.) whilst in the case of the other one to which the name "South Coast" strain has been applied, commercial crops have been observed to contain up to about 40 per cent. of plants showing the condition. In other respects, such as seed shape and colour, type of pod and bush, anthracnose-resistance and ability to grow and set pods under cool conditions, the strains appear to be identical. It has been possible to trace the Tenterfield strain back to the seed released in 1928 as Tweed Wonder but this has not been possible in the case of the South Coast strain.

Mass field roguing of seed crops of the South Coast strain in which all plants showing mottle leave have been removed

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appears to have reduced the percentage of mottle leaf, but has not eliminated the condition, even when such field roguing has been continued for several generations.

Similar symptoms have been observed in commercial crops of Canadian Wonder but other varieties, including Brown Beauty, Hawkesbury Wonder, Wellington Wonder and Landreth Stringless, have appeared to be free of plants containing mottle leaf symptoms.

Previous reports on non-infectious variegations in beans

Burkholder and Muller (1926) described a conditions in beans which they termed "pseudo-mosaic" and which appeared to be a hereditary abnormality, the expression of symptoms being governed by two recessive factors. Parker (1933) described a condition in beans which was not sap-transmissable, which he termed "yellow spot". He determined the factor for yellow spotting to be incompletely dominant to normal green, intensely spotted plants being homozygous dominants. Later the same author (1934) described another type of chlorophyll deficiency which he termed "variegation" and which appeared to be cytoplasmically inherited, "variegation" being possibly influenced by the amount of extra gametal material from a variegated parent which found its way into the seed. During a survey of the New York canning bean crops in 1936, Harrison and Burkholder observed dwarfing and malformation of leaves accompanied by a mosaic pattern in plants of the variety Wisconsin Refugee, which is immune to common bean mosaic. Horsfall *et al* (1937) in the same State in the following year, described a disease of Idaho Refugee and Wisconsin Refugee varieties which they termed "one sided" mosaic. Zaumeyer (1938) found a non-parasitic variegation in hybrids in which Corbett Refugee was used as one of the parents. This was dissimilar to that previously described by Parker (1933, 1934). Zaumeyer (*loc. cit.*) found this variegation to be a heritable defect which he later (1942) divided into two types, one type—variegation of both primary and trifoliate leaves—being inherited as a double recessive with expression of symptoms possibly influenced by other inhibiting factors; the other type, which was confined to the trifoliate leaves, was also described but its mode of inheritance was not discussed.

Symptoms

The symptoms on Tweed Wonder beans may appear on both the primary leaves and the trifoliate leaves, but mottling is not always evident on the primary leaves. The mottling of the primary leaves varies from a few scattered patches of yellow to a general yellowing of the leaves with only a few scattered islands of green evident. Mottling is not so markedly delimited by veins on the primary leaves as it often is on the trifoliate leaves. No marked reduction in size has been observed in mottled primary leaves nor

Figure 1.
Leaves of Tweed Wonder Bean showing typical mottle leaf symptoms.

Figure 2.
Retardation of growth of the mottled side of two leaflets giving distortion of the leaf.

were these leaves puckered or otherwise distorted.

Mottling of the trifoliate leaves, which is sometimes evident very soon after such leaves unfold, takes a number of forms. In lightly affected leaves, one or more leaflets show only a few small islands of yellow or white tissue which may be sharply defined by the smaller veins or which may grade imperceptibly into the normal green of the leaflet (Figure 1). Small isolated yellow areas give the whole leaflet a speckled appearance somewhat similar to that described by Parker in 1933 (Figure 1). When a greater portion of the leaflet is affected, larger veins often form the borders of the yellow or white areas; one side of a leaf may be completely affected and the other side apparently healthy. On severely mottled leaflets only a few smaller islands of green tissue are evident. The sectored effect due to vein delimitation of the leaflet discolouration is the most common expression of the disease. Following retardation of growth in mottled sections, there is distortion of leaflets similar to that described by Horsfall *et al* (*loc. cit.*) and Zaumeyer (1938, 1942). This is shown in Figure 2. One, two or three

TABLE I

Carry over of mottle leaf in sowings from apparently healthy plants (*Figures are actual numbers of plants*).

Row No.	DAYS AFTER PLANTING								
	25			40			60		
	Healthy	Mottle	Dwarf Mottle	Healthy	Mottle	Dwarf Mottle	Healthy	Mottle	Dwarf Mottle
1	47	—	—	46	1	—	42	5	—
2	50	—	—	50	—	—	45	5	—
5	46	3	—	41	6	1	39	8	1
7	49	—	—	49	—	—	47	2	—
8	36	5	1	34	9	2	34	9	2
15	44	3	—	42	4	1	42	4	1
Remaining 11 rows	485	—	—	485	—	—	485	—	—

leaflets of a leaf may be mottled, but where all three leaflets are affected, the distortion and recurving of midribs is not so common as where only one or two leaflets are mottled.

In the field, and also in glasshouse plantings of Tweed Wonder beans, plants to which we have applied the term "dwarf mottle" sometimes appear. The condition of these plants—rosette form, severe leaf yellowing and short internodes—agrees with the descriptions given by Zaumeyer (*loc. cit.*) of extremely variegated plants which do not die in the seedling stage. Often, however, these "dwarf mottle" plants will send out shoots of normal size and shape which appear healthy or show milder mottling of the leaves.

Pods produced by "mottle leaf" affected plants are not distorted and recurved as described by Zaumeyer (*loc. cit.*) in the case of Corbett Refugee hybrids.

Expression of mottle leaf may occur over most of the leaves or may be confined to the upper or the lower leaves. Mottling of an individual plant is often not evident till a later stage in its growth and, vice-versa, a lightly mottled plant may later appear healthy. Repeated plantings have shown that this masking of mottle leaf symptoms can occur during the life of a plant and seed from apparently unaffected plants will give rise to mottled ones. This masking only occurs in lightly mottled plants. Once severe mottling and distortion occurs no masking takes place.

Experiments on seed carry-over

Seventeen single plant selections were made from a seed crop of the South Coast strain just before the crop was ready to harvest. This crop had been thoroughly mass-field-rogued for mottle leaf several times throughout the growing period. Seed from each of these 17 plants was planted in single rows at Carlingford, New South Wales, and inspected 25, 40 and 60 days after planting. The results of the inspections are shown in Table I.

In 6 of the 17 rows some mottle leaf affected plants were recorded and, in three rows, dwarf mottle plants. In the remaining 11 rows no plants affected with mottle leaf were observed. Seed was saved from the Carlingford plots and plantings later made at the Botanic Gardens, Sydney, with bulked seed from rows 1, 2, 7 and 15, a total of 750 seeds being planted of which 507 germinated. The

TABLE II

Total percentage of mottle and dwarf mottle plants from the same seed lots showing also how the symptoms can be masked.

Ex Row	DAYS AFTER PLANTING								
	22			26			60		
	Healthy	Mottle	Dwarf Mottle	Healthy	Mottle	Dwarf Mottle	Healthy	Mottle	Dwarf Mottle
1	93.5	6.5	—	78.3	17.1	4.6	87.7	9.5	2.8
2	99.4	0.6	—	99.4	0.6	—	99.4	0.6	—
7	99.3	0.7	—	98.6	1.4	—	100.0	—	—
15	62.0	38.0	—	33.9	51.7	14.4	70.0	24.0	6.0

TABLE III

Inter-relationship of location of mottling on the parent plant and on the offspring (Figures are actual numbers of plants).

Condition of parent plants	Number of resulting plants classified as					Total Plants
	H	U	L	D.M.	M(G)	
H	2	0	0	0	4	6
U	7	0	4	1	28	40
L	4	1	1	0	0	6
D.M.	3	1	2	0	4	10
M(G)	6	1	2	0	2	11
S	3	0	1	0	8	12
M, then H	3	0	0	0	4	7

Abbreviations used:—

H = healthy (all-green).
U = mottle on upper leaves only.
L = mottle on lower leaves only.
D.M. = dwarf mottle.
M = mottle.
M(G) = general mottle on upper and lower leaves.
S = speckled (doubtful mottle leaf).

plants were examined 22, 26 and 60 days after sowing, the results being shown in Table II. Plants with symptoms of mottle leaf had appeared earlier in rows 1 and 15 than in rows 2 and 7 in the Carlingford planting and it is of interest that these two rows (1 and 15) showed a higher degree of mottle leaf carry-over. The results for row 15 in Table II show clearly that mottle leaf symptoms can become evident in a greater part of the plants within a few days and later become more than 50 per cent. masked. Dwarf mottle effects also developed in the progeny of plants from rows 1 and 15 within four days after the first examination and later some of these plants developed normal apparently healthy foliage or less severely mottled foliage.

Relationship between location of mottle symptoms on parent plant and on progeny

Seed from plants in rows 5, 8 and 15 grown at Carlingford (see Table I) was planted in a glasshouse and the resulting plants examined at frequent intervals to see what correlation, if any, existed between the condition of the parent plant and the occurrence of mottle leaf symptoms in the progeny. The results of observations on 92 plants are shown in Table III. It will be noted that apparently healthy "all green" plants produced both mottle leaf and apparently healthy plants as did also the mottle leaf parents and that there appeared to be no definite correlation between the loca-

tion of symptoms on the parent plant and on the progeny.

Influence of mottle leaf on yield

Field observations and reports of growers over a number of years have not yielded any conclusive evidence that the presence of mottle leaf in a line of Tweed Wonder beans adversely affects the yields of either seed or green beans to any great extent when compared with other varieties or with the Tenterfield strain of Tweed Wonder growing under similar conditions. It is obvious, however, that where any appreciable proportion of the plants show the dwarf mottle condition yields must be reduced since, as indicated above, dwarf mottle plants are stunted and produce practically no pods.

In one small experiment in which single plant progenies were sown in the glasshouse, seed yields from lines affected with mottle leaf were considerably lower than those of lines in which all the plants appeared free of mottle leaf (Table IV).

TABLE IV

Effect of mottle leaf on seed production

	No. of Plants	No. of seeds produced	Average No. of seeds per plant
Lines of seed showing mottle	72	888	12.3
Lines, all plants in which were apparently healthy	20	431	21.5

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CONTROL OF DOLLAR SPOT OF TURF IN CANBERRA, A.C.T.

During the latter part of 1948 dollar spot, due to *Sclerotinia homoeocarpa* Bennett caused considerable damage to golf greens in Canberra. The disease was most common under humid conditions in spring and autumn but also appeared under similar conditions in summer. It was not observed at average weekly temperatures below 65°F.

The work reported here was done at the Royal Canberra Golf Club where the greens consist mainly of creeping bent (*Agrostis tenuis* Sibth.) and Chewings fescue (*Festuca rubra*, var. *fallax* Hack.). Dollar spot affected almost every green on the course. It was noticed that all diseased greens had a high population of grass webworms (*Calamotropha leptogrammelus* Meyr.). Efforts of the maintenance staff to control the disease with a mixture of mercurous and mercuric chlorides had failed.

In February, 1949, an investigation was begun to test the effectiveness of various turf fungicides against dollar spot. Because webworm injury was a possible contributing factor an insecticide treatment (D.D.T.) was included. Shortly after the commencement of treatment, environmental conditions became unfavourable for the development of the disease and no reliable results were obtained. Regular inspections of the course were made in the following months and at the first signs of recurrence of the disease in early October 1949, treatments were re-applied and continued until mid-March, 1950.

Plots six feet square were laid out on a badly affected area with a one-foot wide buffer zone between adjacent plots. Before treatment each plot supported some healthy turf. Treatments were replicated four times and were applied with a garden type spray.

Details of treatments applied are:—

(a) *P.A.C.A.**: *phenyl-amino-cadmium acetate.* A 0.1 per cent. aqueous solution applied fortnightly at the rate of fifty gallons per six hundred square yards.

(b) *C.C.*531**: *a calcium-zinc-copper-cadmium-chromium complex.* A 0.1 per cent. aqueous suspension applied fortnightly at the rate of fifty gallons per six hundred square yards. This material is identical with the American fungicide Crag 531 (private communication with suppliers).

(c) 1.5 *oz. each of mercurous and mercuric chlorides* suspended in fifty gallons of water applied monthly at the rate of fifty gallons per thousand square feet.

(d) *T.M.T.D.*†: *tetra-methyl-thiuram disulphide.* 1.5 lb. suspended in forty-eight gallons of water applied fortnightly at the rate of forty-eight gallons per six hundred square yards.

(e) *D.D.T.*: *Diphenyl-dichloro-trichlorethane.* A 0.1 per cent. aqueous emulsion at the rate of fifty gallons per six hundred square yards applied in February and October, 1949.

(f) *P.A.C.A.* + *D.D.T.*: P.A.C.A. applied as in (a) and D.D.T. applied as in (e) above.

(g) *Control*: No treatment.

*Supplied by E. P. Keogh Pty. Ltd., Melbourne.
**Supplied by Pest and Plant Control Ltd., New Zealand.
†Supplied by Imperial Chemical Industries of Australia and New Zealand Ltd.

Between February 14 and March 21, 1950, each plot in the experimental area was rated for severity of dollar spot. The averages of five ratings are presented in Table I. Severity was rated on a 0-5 basis—0 indicating complete control of the disease and recovery of turf, and 5 indicating a spread of the disease so that all turf in the plot was infected.

TABLE I

Response of dollar spot infected turf to treatments.

Treatment	Applications	Average Rating 0-5
P.A.C.A. + D.D.T.*	P.A.C.A. fortnightly D.D.T. twice only	0.3
P.A.C.A.*	Fortnightly	0.4
C.C.531*	Fortnightly	0.7
HgCl + $HgCl_2$*	Monthly	0.7
T.M.T.D.	Fortnightly	2.8
D.D.T.	Twice only	3.4
Control		3.2

*These treatments are not significantly different one from another, but they are significantly different from the other treatments.

During the experiment the healthy plants occurring between the actual "dollar spots" were kept under observation to determine whether any treatment affected the vigour of normal turf growth. A mixture of mercurous and mercuric chlorides was the only treatment which had a detrimental effect. The general appearance of healthy turf was better in P.A.C.A. plots than in any other.

The results of the work showed that P.A.C.A. and C.C.531 gave good control when applied fortnightly during late spring, summer and early autumn. They caused no injury to the turf. A mixture of mercurous and mercuric chlorides, applied once a month during the same period gave equally good control but retarded growth of turf. T.M.T.D.applied fortnightly appeared to control the disease slightly but results of ratings were not significant. D.D.T. applied twice during the experiment did not control the disease, nor did it increase the effectiveness of P.A.C.A. Since it was observed that D.D.T. effectively controlled webworms in this experiment and had no effect on dollar spot, it is evident that webworms did not increase the susceptibility of turf to the disease.

Of the treatments used, P.A.C.A. gave the most satisfactory control of dollar spot. Since the completion of the experiment this material has been used as a routine turf treatment on all greens at the Royal Canberra Golf Club whenever environmental conditions were considered favourable for the development of the disease. Effective control of dollar spot has been obtained and quality and vigour of turf have not been affected. On several occasions portions of greens were not treated and the disease reappeared.

These results show that a practical method of controlling dollar spot is available.

Grateful acknowledgment is made to Mr. G. A. McIntyre, Section of Mathematical Statistics, C.S.I.R.O., for analysing results. Following the death of the senior author, advice on the preparation of the manuscript has been given by Mr. J. H. E. Mackay, Division of Plant Industry, C.S.I.R.O.

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THE USE OF TRISODIUM PHOSPHATE AS AN INACTIVATING AGENT FOR PLANT VIRUSES

Formalin is the commonly used sterilizing agent in plant virus work; while it is reasonably effective for sterilizing instruments it is unsuitable for disinfecting workers' hands. Its replacement by a more effective and less objectionable substance is highly desirable.

A survey of the literature on virus inactivating substances showed that many substances of inorganic, organic and biological origin have been successfully employed. Among the most effective substances reported were mercuric acetate, silver nitrate, safranine and tannic acid (Stanley, 1935), Phytolacca extract (Duggar and Armstrong, 1925), growth products of certain micro-organisms (Johnson and Isme, 1937), urea (Bawden and Pirie, 1940), trisodium phosphate (Van der Weij, 1941), bromine water, formalin, blood serum, aphid extracts and milk (Johnson, 1941), extracts of spinach, silver beet and chard (Kuntz and Walker, 1947). Of the substances listed in the literature as being effective inactivators, most were unsuitable. Some had corrosive or other objectionable properties, others were expensive or inaccessible and some were reported as being unreliable. It was decided to compare several of the most suitable substances for their effectiveness as inactivators when added to virus preparations and when used as disinfecting solutions.

Each of the substances was mixed with virus inoculum and the mixtures were used to inoculate plants of *Datura stramonium* and *Capsicum* sp. in tests with potato virus X, and *Nicotiana glutinosa* in tests with tobacco mosaic virus (T.M.V.). Inoculations were done immediately after mixing and again after standing for five minutes. It will be seen from Table I that trisodium phosphate is much more effective than the commonly used formalin in inactivating both virus X and T.M.V.

Subsequently a replicated experiment was conducted to determine the effectiveness of three concentrations of Na_3PO_4 against three levels of T.M.V. inoculum using *Nicotiana glutinosa* as the indicator plant.

Ten grams of young leaves of Turkish tobacco infected with T.M.V. were ground with 50 ml. water to make the inoculum; 1/10 and 1/100 dilutions were made to provide the three levels of virus concentrations. Equal parts of water, 5 per cent., 10 per cent. and 20 per cent. Na_3PO_4 were added to aliquots of the inoculum and inoculations done immediately and after standing for five minutes. It will be seen from Table II that the effectiveness of any concentration of Na_3PO_4 used is related to both the concentration of the virus present and the time the mixture is allowed to stand. However, the addition of 5 per cent. Na_3PO_4 immediately reduced the active concentration of the virus as much as a hundred-fold dilution with water while 20 per cent. Na_3PO_4 immediately reduced the active concentration as much as a thousand-fold dilution and after five minutes as much as ten thousand-fold dilution. Although Na_3PO_4 is more effective as an inactivating agent than for-

TABLE I

Transmission of Virus X and T.M.V. when inoculum mixed with equal parts of various inactivators.

	Transmission of Virus X		Transmission of T.M.V.	
	Inoculation		Inoculation	
	Immediate	After 5 minutes	Immediate	After 5 minutes
Na_3PO_4 20%	—	—	+	—
10%	+	—	+	—
5%	+	—	+	—
2%	+	+	+	+
1%	+	+	+	+
Formalin (Commercial)				
100%	—	—	+	+
50%	+	—	+	+
10%	+	+	+	+
Ethyl Alcohol	+	+	+	+
Milk	+	+	+	+
Soapy Water			+	+*
Water Control	+	+	+	+

*Significantly less lesions with soapy water than with tap water control.

malin (Table I), even at a concentration of 20 per cent. some T.M.V. particles remain active after five minutes (Table II).

Experiments were conducted with Na_3PO_4, formalin and alcohol as sterilizing media for instruments. Pestles and mortars which had been used to grind up tissue infected with virus X and T.M.V. were each rinsed with one of the substances under test followed by three rinses in running water. A small quantity of water was added to the mortar and check inoculations made to *D. stramonium* and *Capsicum* sp. for virus X and to *N. glutinosa* for T.M.V. Virus X was transmitted following rinsing with

TABLE II

Mean Number of Lesions Produced by T.M.V. on Nicotiana glutinosa.

Concentration of inoculum	Inoculation immediately				Inoculation after 5 mins.			
	Substance added to inoculum				Substance added to inoculum			
	Water	Na_3PO_4			Water	Na_3PO_4		
		5%	10%	20%		5%	10%	20%
1	717	114	47	9	941	14	3	1
1/10	637	31	4	2	798	0	1	1
1/100	122	8	5	0	185	0	0	0

formalin; absolute alcohol; 1 per cent. and 2 per cent. Na_3PO_4 but not following 5 per cent., 10 per cent. or 20 per cent. Na_3PO_4. The only failure to transmit T.M.V. was following rinsing with 20 per cent. Na_3PO_4, but where a thorough wash was made or where the instruments were immersed in the liquid for half to one minute both 10 per cent. and 5 per cent. Na_3PO_4 prevented transmission.

Thus a 10 per cent. Na_3PO_4 solution is recommended as a safe and effective sterilizing agent against T.M.V. and virus X for both instruments and hands. Long or frequent immersion of hands may cause temporary irritation but this has not been a serious disadvantage over some months of use. Washing with soap and water has been shown to be more effective in reducing the virus concentration than washing with water alone and it is suggested that the inactivating action of Na_3PO_4 is due to its properties as a detergent and its high pH value (11.8).

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BOOK REVIEW

THE ORIGIN, VARIATION, IMMUNITY AND BREEDING OF CULTIVATED PLANTS — SELECTED WRITINGS OF N. I. VAVILOV

TRANSLATED FROM THE RUSSIAN BY K. STARR CHESTER

(*Chronica Botanica* 13 (1-6), *Chronica Botanica Co. Waltham, Mass., U.S.A. and N. H. Seward, Melbourne;* 1951, 366 *pp.*, $7.50).

The publication in 1935 of the "Theoretical bases of plant breeding" under the editorship of N. I. Vavilov marked the beginning of a new era in the theory and practice of plant breeding. To this work Vavilov contributed articles on the origin of cultivated plants, the law of homologous series in variation, the immunity of plants from diseases and the scientific bases of wheat breeding. The volume under review consists of a full translation of such contributions.

In his preface Chester offers these translations that "those who were not privileged to have known Vavilov may find their scientific experiences enriched, their minds stimulated and their research energized by better acquaintance with the work and philosophy of one of the most memorable figures in the history of plant science."

As the writings of Vavilov are now twenty years old much of this work is of purely historical interest and yet the reviewer feels sure that many Australian workers will find much that is essentially new to them.

To take but one example, the reading of this volume might well lead to a new outlook on plant introduction. In the development of Australian agriculture we have been completely dependent for our plant material on importations from overseas. This being so, it is difficult to understand why there has not been a greater awareness of the principles of plant introduction as enunciated by Vavilov in his discussion on the phytogeographic basis of plant breeding. The early Australian workers with wheat appreciated the need for extensive and systematic introductions and it is nice to know that Vavilov pays a tribute to their work. A similar appreciation is needed to-day when attention is being directed to new crops, for, as Vavilov points out, their success or failure is inseparably bound up with the varieties originally chosen for cultivation.

The volume is well produced but the high price must limit its sale in this country.

A. T. PUGSLEY.

PELLETED SUBTERRANEAN CLOVER SEED IN PASTURE ESTABLISHMENT

Reference has been made in the literature to the use of pelleted seed, with or without the incorporation of fertilizers and fungicides, in the reseeding of forest areas, the establishment of lawn and in vegetable culture (Linn, 1948; Wagner, 1949). Large scale field tests with pelleted seed have been made overseas. The work has shown that with aeroplane seeding of range lands better seed distribution is obtained with pellets (Stewart, 1949); but data comparing the establishment obtained with pelleted and unpelleted seed have not been available. It was considered that pelleted seed might overcome the normally high seedling mortality rates associated with the broadcasting of seed in the establishment of sown species on natural pasture.

In this study the pellets were made of the same materials as have been used overseas. They consisted of a binding agent, a water soluble plastic (methyl cellulose) and felspar. Bacchus Marsh subterranean clover (*Trifolium subterraneum* L.) with a germinating capacity of 96 per cent. was coated to give small and large pellets which were spherical in shape. The Bacchus Marsh seed was tested in three forms; unpelleted (66 thousand seeds per lb.), small pellets (24.5 thousand seeds per lb.) and large pellets (9 thousand seeds per lb.). It was considered that the larger pellets approached a maximum size for mechanical distribution.

Under laboratory conditions the coating absorbed moisture evenly and spread at the base to form a mound in which the seed was embedded. Further, as the binding material of the pellet had dissolved, the cotyledons were unrestricted in their development.

In the field, seed was broadcast at the rate of 4 lb. per acre with 1 cwt. of superphosphate per acre on natural pasture at Weetangera, Australian Capital Territory. This pasture had developed on a sedimentary soil and had been grazed previously. Its main components were *Danthonia* spp., *Enneapogon nigricans* (R. Br.) Beauv., *Bothriochloa ambigua* S. T. Blake, and the naturalized legumes—clustered clover (*Trifolium glomeratum* L.) and woolly clover (*Trifolium tomentosum* L.). Sowings were made on two occasions, May 13 and September 21, 1949. On each occasion there were fifteen plots arranged in a conventional randomized block design, which allowed five replications of the three treatments.

The laboratory experience was not confirmed under field conditions. The coating tended to crack concentrically, probably due to the fact that the water soluble plastic did not dissolve. Complete disintegration occurred four to six weeks from sowing. The cotyledons had to force their way through the coat finally throwing it off.

The results of establishment counts taken in the field are shown in Tables I and II.

TABLE I

Establishment of subterranean clover ten weeks from sowing (Percent)

	Unpelleted	Small pellets	Large pellets	Significance
1st sowing	43.4	34.7	33.1	n.s.
2nd sowing	20.0	16.5	13.0	n.s.
1st + 2nd sowing	31.7	25.6	23.0	$P<.01$

In both sowings the results obtained showed that pelleting did not increase the percentage establishment. In fact, at ten weeks from sowing (Table I) a reduction in establishment with pelleting and increasing pellet size was recorded in the

combined sowings. At eighteen weeks from sowing this effect was not significant (Table II).

TABLE II

Establishment of subterranean clover eighteen weeks from sowing (Percent)

	Un-pelleted	Small pellets	Large pellets	Signifi-cance
1st sowing	26.0	27.3	27.3	n.s.
2nd sowing	17.1	11.1	11.3	n.s.
1st + 2nd sowing	21.7	19.2	19.4	n.s.

Rainfall for the year was in excess of the annual average. In the four months preceding the commencement of the experiment 1.3, 3.5, 3.2 and 1.1 inches of rain were recorded. In succeeding months of the experiment 3.8, 1.5, 2.0, 0.5, 3.2, 4.4, 3.3 and 0.8 inches of rain fell. Moisture conditions were therefore particularly favourable for the establishment of the clover. Despite this, only twenty per cent of the seed broadcast on the surface survived to maturity, irrespective of treatment.

It appears unlikely that pelleting of subterranean clover seed will even partially dispense with the need for cultivation and covering the seed in establishing plants under field conditions. This agrees with the opinion recently expressed by Barnard (1950).

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BOOK REVIEW

TRACE ELEMENTS IN PLANT PHYSIOLOGY — A SYMPOSIUM

By J. F. H. WRIGHT

(*Chronica Botanica Co., Waltham, Mass., U.S.A., N. H. Seward Pty. Ltd., Melbourne.* 1950. 144 *pp. Price* $4.50.)

On November 5th and 6th, 1947, a symposium on trace elements, organized by the International Union of Biological Sciences, with the support of U.N.E.S.C.O., was held at the Rothamsted Experimental Station, Herts., England. Fourteen papers which were presented at the Conference are now published in book form, together with some of the discussion of the main points arising from each. Those who have contributed papers are: T. Wallace, E. J. Hewitt, L. Gisiger, D. I. Arnon, E. G. Mulder, J. Erkama, M. P. Löhnis, H. Burström, D. Mulder, F. Steenbjerg, E. A. Jamalainen, J. Lavollay and L. Seekles. The opening address was given by the late Professor B. Nemec.

Three of the papers deal with the application of the method of visual diagnosis to trace element problems in plants, and the highly refined sand and water culture techniques necessary for the conduct of fundamental studies with elements such as molybdenum. The functions of trace elements in plants are discussed in four papers. These comprise the effects of copper and molybdenum on *Aspergillus niger* and on higher plants; the interaction of manganese, copper and iron; the action of manganese and nitrate on roots; and the coefficient of action of mineral nutrients. The remaining papers deal with investigations of particular trace element problems occurring in European crops. These include the injury caused by excess manganese, or by overliming; zinc deficiency in fruit trees; copper and other deficiencies in Denmark and Finland, and the mode of action and occurrence of trace elements in pastures and in the blood and liver of farm animals.

There are 27 text figures, 27 tables and 10 plates, and an author index is provided.

As would be expected from a group of authors such as those listed above, the symposium is authoritative, and will prove of value to all who have an interest in recent advances in our knowledge of the practical and fundamental aspects of trace elements in plant nutrition.

C. R. MILLIKAN.

INSTITUTE AFFAIRS

COUNCIL PROCEEDINGS

A regular meeting of Council was held at Canberra on November 7, 1951, and a special meeting on December 14, immediately following a special general meeting of the Institute. The most recent meeting of Council was held on January 23, 1952. A summary of these activities is given below.

Development of the Institute

Acting on a resolution of the September Council meeting, a report on a system of rebates to branches and the subscription rates to finance the scheme, together with a budget of income and expenditure for Council under these adjusted conditions, was prepared by a Council sub-committee and forwarded to branches for comment. In addition, alternative motions for the alteration of the Articles of Association to allow for increased subscription rates were circulated to members.

General agreement was expressed at the October Council meeting with the rebate system and recommended subscription rates. Following the acceptance at the general meeting of December 14 of amendments to Articles which now permit Council to fix subscription rates, it was resolved at the special meeting of Council that the subscription for 1952 would be two guineas for corporate members and ten shillings for students.

A.I.A.S. Scholarship Scheme

There was considerable discussion at the October meeting of the report by the Sub-committee appointed by Council on the details of administration of the scheme. While some branches still objected in principle to the establishment of the scheme, there was general agreement with the details of the report except on two points, namely—

(a) the organization of the selection committee, and
(b) more explicit reference should be made in the governing clauses to advanced study as well as to research.

These minor amendments were referred back to the Sub-committee for comment. It was resolved—

"That Council record in its minutes its grateful appreciation of the work of Dr. H. G. Andrewartha, Professor J. R. A. McMillan and Associate Professor G. W. Leeper in the preparation of this report."

Rural Extension Services

Following the circulation of an earlier report on rural extension services (*J.Aust. Inst. Agric. Sci.* 17: 5 161), further views on the organization and scope of rural extension services have been sought from branches. Detailed statements have now been received from the Tasmanian and Western Australian Branches. A sub-committee has been appointed by Council to collate branch reports.

Affiliated Membership

A questionnaire sent to branches for the purpose of defining more exactly their views on the terms governing this proposed class of membership and as a step towards securing unanimity, revealed the wide diversity of views currently held. It was considered by Council that direct consideration of the primary factors in favour of and against the proposal may reduce the divergence. No action in the form of amendments to the Articles is contemplated before the general meeting of the Institute to be held in August.

Membership Emeritus

Branch comments on draft rules governing this class of membership were considered at the October meeting. Queensland and Western Australia dissented in principle with the creation of this class of membership. However the remaining branches substantially agreed on detail and it was resolved that draft articles on membership should be submitted for consideration at the Annual General Meeting.

MEMBERSHIP

ADMISSIONS

With the recommendation of the branch submitting the application and the Qualifications Committee, the following applications were approved for **Corporate membership:**

117th Council Meeting

Beale, C. I. A.	Victoria
Black, J. D. F.	,,
Dexter, Mrs. E. A.	,,

Easton, Miss G. R. .... Victoria
Fisher, Miss E. E. .... „
Foord, Miss B. W. .... „
Harding, C. R. .... „
Higgins, K. B. .... „
Honybun, D. L. .... „
Kehoe, J. K. .... „
Kendall, F. J. E. .... „
Morris, D. S. .... „
Nicholson, B. M. .... „
Pryke, P. I. .... „
Rooney, D. R. .... „
Simmons, E. K. .... „
Summons, R. St. G. .... „
Tudor, W. B. .... „
Van Baer, R. A. .... „
Wardle, B. R. .... „
Berryman, J. W. .... „
Belford, Miss C. A. .... Western Australia
Cooke, F. M. .... „ „
Drover, D. P. .... „ „
Poutsma, T. .... „ „
Williams, B. .... „ „
Carter, M. V. .... South Australia
McGlasson, W. B. .... „ „
Roe, G. P. .... „ „
Andrew, C. S. .... Queensland
Beattie, A. W. .... „
Evans, A. M. .... „
Sturgess, O. W. .... „
McLennon, L. W. .... New South Wales

119th Council Meeting

Godwin, D. B. .... Victoria
Keatley, J. .... „
Wright, M. E. .... „
Cannon, D. J. .... „
Hird, F. J. R. .... „
Mann, A. P. .... „
Christian, J. H. B. .... New South Wales
Hordern, R. M. .... „ „ „
Connor, Miss J. .... „ „ „
Colbran, R. C. .... Queensland
Robertson, W. G. .... „
Richards, R. R. .... Tasmania
Dimmock, G. M. .... „

121st Council Meeting

Petterson, A. S. .... New South Wales
Vane, N. W. .... „ „ „
Phillis, E. .... Aust. Cap. Territory
Slatyer, R. O. .... „ „ „
Garland, K. R. .... Victoria
Rowan, J. N. .... „
Christen, F. F. .... „
Wallace, M. M. H. .... Western Australia

With the recommendation of the branch submitting the application, the following applications were approved for **Student membership:—**

117th Council Meeting

Arundell, P. .... Victoria
Bromell, J. E. .... „
Butler, R. M. .... „
Cameron, N. G. .... „
Davidson, B. R. .... „
Dettman, Miss M. G. .... „
Edmonds, J. W. E. .... „
Elvery, D. H. ....
Freer, M. .... „
Hotton, Miss G. B. .... „
Lesock, F. J. .... „
MacIntyre, Miss B. M. .... „
McIntyre, I. A. .... „
McKinley, G. A. .... „
Marshal, I. D. .... „
Naylor, Miss J. B. .... „
Parsons, W. T. .... „
Rowan, R. H. .... „
Rowley, I. C. R. .... „
Straw, Miss C. W. .... „
Anderson, A. C. N. .... Western Australia
Bean, M. P. S. .... „ „
Carpenter, J. A. .... „ „
Chao, L. L. .... „ „
Cleeve, Miss M. L. .... „ „
Fisher, H. M. .... „ „
Gladstones, J. S. .... „ „
Gooding, C. D. .... „ „
Grewar, G. R. .... „ „
Hedges, Miss D. L. .... „ „
Keightley, G. S. .... „ „
Lewis, J. W. .... „ „
Newton, K. .... „ „
Ralph, C. M. .... „ „
Ramm, P. D. .... „ „
Smith, R. D. .... „ „
Snow, Miss M. M. .... „ „
Stewart, Miss J. .... „ „
Whitely, K. T. .... „ „
Wilcox, D. G. .... „ „
Herne, P. K. .... New South Wales
Joyner, P. V. .... „ „ „
Madden, C. P. .... „ „ „
Morgan, K. A. .... „ „ „
Perry, T. R. .... „ „ „
Tims, A. V. .... „ „ „
Walker, M. H. .... „ „ „
Weston, R. H. .... „ „ „

119th Council Meeting

Dhar, V. .... Victoria
Barber, I. A. .... New South Wales
Jessup, R. J. .... „ „ „

McLeod, N. O. .... New South Wales
Richards, Miss J. M. .... „ „ „
Teakle, D. S. .... Queensland
Saunders, G. W. .... „
Rosser, A. .... „
Denmead, O. T. .... „
Beames, R. M. .... „
Jones, E. .... „
McCowan, N. .... „
Cusack, O. J. .... „
Patil, S. V. „

CANCELLATION OF STUDENT MEMBERSHIP

The following student memberships were cancelled on the advice of the New South Wales Branch.

119th Council Meeting

George, J. M.
Block, R. W.
Bickley, K. S.
Strang, J.
Dyce, A. L.
Lewis, D. A.
Morrison, A. K.
Valder, P. G.
Hogan, J. P.
Newman, J. C.
Mackey, B. E.
Walker, D. E. H.
Wright, W. E.

121st Council Meeting

Seeman, Miss E. E.
Morse, B. V.
Garrett, J.
Waring, S. A.
May, P. F.
Potter, R.
McGrath, J. G.
Pulsford, D. J.
Croft, T. J.
Stannard, M. E.
Brady, C. J.
Sandiford, R. N.
Upton, M. I.
Evans, A. M.
Corbould, A.
Dent, J. E.
Hutchinson, K. J.
Monteith, N. H.
Peisker, K. V.
Scott, G. R.

RESIGNATIONS

The resignations of Mr. J. M. Coleman of New South Wales (119th Council Meeting), Miss M. P. Eggleston and Dr. J. S. Hosking of Victoria, Dr. H. R. Seddon and Mr. S. Case of New South Wales (121st Council Meeting) were accepted by Council with regret.

TRANSFERS

The following transfers have been noted:—

R. A. Sherwin—New South Wales to Australian Capital Territory;

A. G. Itzerott—Victoria to South Australia;

A. L. Gurnett-Smith—New South Wales to Victoria;

R. R. Pennefather—New South Wales to Victoria;

J. H. Taylor—New South Wales to Tasmania;

P. F. Butler—South Australia to Victoria;

W. D. Hardy—Australian Capital Territory to Victoria;

P. McGowan—Tasmania to Victoria;

C. H. S. Dolling—South Australia to Queensland;

L. F. Myers—New South Wales to Australian Capital Territory.

TERMINATIONS

Acting on the recommendation of the New South Wales Branch, the following memberships were terminated.

G. K. Adkins.
D. J. McFarlane.
P. Vaidynathan.

SEVENTEENTH GENERAL MEETING

This special general meeting was held at Canberra on December 14, 1951, to consider amendments to the Articles of Association clauses governing the rate of subscription. Alternatives before the meeting were:—

(a) motion 1 granting additional powers to Council including the right to alter the subscription rate with motions 2 and 3 as consequential amendments to Articles 6 and 9; and

(b) motions 4 and 5 specifying new rates for subscriptions in Articles 6 and 9.

Motions 1, 2 and 3 were carried by 165 votes to 146. The amended Articles 35, 6 and 9 read as follow:—

35. The management and government of the business and affairs of the Institute shall be vested in a Council the members whereof in addition to the powers and authorities by these Articles or otherwise expressly conferred upon them may exercise all such powers and do such acts and things as may be exercised and done by the Institute and are not by these Articles or by Statute expressly directed or required to be exercised or done by the Institute in general meeting but subject nevertheless to the provisions of the Statutes and these Articles and to any regulations from time to time made by the

Institute in general meeting provided that no regulations so made shall invalidate any prior act of the Council which would have been valid if such regulation had not been made. The Council shall hold office from the conclusion of one regular general meeting of the Institute to the conclusion of the succeeding regular general meeting. Decisions made at a general meeting of the Institute shall be binding upon the Council.

6. The annual subscription for a corporate member in any financial year shall be determined in advance by the Council. In addition a corporate member shall pay such sum or sums for any one year as the Branch of the Institute to which such corporate member belongs may declare to be payable by its members for the conduct of its activities. At its discretion the Council may reduce or waive the subscription of a corporate member travelling overseas for any purpose for a period of not less than twelve months.

9. The annual subscription for a student member shall be determined in advance by the Council. In addition a student member shall pay such sum or sums for any one year as the Branch of the Institute to which such student member belongs may declare to be payable by its members for the conduct of its activities.

BRANCH NOTES

Queensland

At the general meeting held on the 29th August, Mr. C. G. Hughes delivered his Presidential Address on "The 1951 Cane-collecting Expedition to New Guinea." Mr. Hughes discussed the history of cane collecting in New Guinea and then spoke in detail of the present expedition which explored the inland highland region around Aiyura, Goroka, and the Chimbu area. At a later date it is hoped to present a full account of Mr. Hughes' address in this Journal.

At the meeting held on September 26, Mr. W R. N. Nathaniel of the Cocoanut Research Institute, Ceylon, gave a talk on "Ceylon, with special reference to the cocoanut industry." Mr. Nathaniel stated that the cultivation of the cocoanut was of minor importance until the arrival of the Dutch in Ceylon in 1658. The present acreage of cocoanuts is estimated at 1.1 million acres, 50 per cent. of the cocoanuts being consumed locally, and the remainder producing an annual revenue from exports of £25-30 million. While the tall cocoanut is the more important commercial type, most of the estates grow a few of the fancy dwarf varieties. The present scheme for research on cocoanuts was begun in 1930 and the work is now covered by the Divisions of Soil Chemistry, Technological Chemistry, Botany, and Replanting.

On October 19, 1951, the Branch held a combined meeting with the Queensland Division of the Australian Veterinary Association, the evening being devoted to a symposium on the cattle industry. Mr R. Chester of the A.V.A. introduced the subject, and was followed by speakers from the Institute.

The meeting of Wednesday, November 21, was devoted to the presentation of student essays in competition for the Branch Prize. This prize is awarded to undergraduates in the Faculty of Agriculture and the award is based firstly on the presentation of a written paper. Three papers are then selected by the judges and the authors are asked to present a short summary to a meeting of members. The award this year was divided between Messrs. B. Champ and L. A. Edye. Mr. Champ chose as his subject, "Insects in relation to the spread of paspalum ergot in the field." A summary of his paper is as follows:—

> "*Pyrellia caerulea*, a metallic green fly, is the principal vector of *Calviceps paspali* in the conidial state in the stands of *Paspalum* studied. It is chiefly concerned with transmission from floret to floret, within the inflorescence. Dissemination by other species is significant only when they are taken together as a group. This group would, in the absence of *Pyrellia* from the stand, effectively transmit the disease."

Mr. Edye's subject was "A Study of a Sandstone Soil". He discussed the sandstone ridges of the Lockyer Valley with special reference to compaction and consolidation and showed how the factors of moisture, aeration, vegetation, mechanical constitution, and pressure affected the situation.

Tasmania

At an Open General Meeting held on October 23, 1951, Mr. F. W. Hicks addressed members and visitors on the subject "Pakistan." With the aid of film strips he described what he had seen as a member of an Australian Survey Mission in connection with the development of the Thal region in Pakistan.

Mr. Hicks emphasised the fact that any agricultural mechanization in Pakistan must be limited by the necessity to employ as many people as possible in a country where the labour supply definitely exceeds the demand. As a result of the partition of India, hundreds of thousands of refugees had crowded into Pakistan, thus adding to the difficulties of an already densely populated country. In an effort to absorb these refugees extensive irrigation projects are being developed. As a contrast to the poverty-stricken conditions of most of the population, Mr. Hicks mentioned the homes and estates of the wealthier people, both native and European.

A General Meeting of the Branch on December 3, 1951, was addressed by Dr. J. H. Wilson on "Some Impressions of Britain, its Agriculture and Agricultural Research."

Dr. Wilson began by stating that practically all of Britain was habitable and arable, and although its agriculture was intensive he did not think that the land was farmed to capacity. The parklands and estates which at present are not used for commercial production, Dr. Wilson considered, may possibly become important as a means of making Britain independent of imports with the exception of meat and fats.

The generally high degree of fertility of land observed was due, not to inherent fertility, but to the building up and maintenance of marginal land by the use of organic and inorganic fertilizers. This, together with the climate and water supply, gives higher crop yields that those of Australia.

Dr. Wilson was very impressed with the thoroughness of research work, but considered that there was a wide gap between research and the actual problems which existed in the field.

To conclude his address Dr. Wilson showed some coloured slides of various parts of Britain.

Victoria

A general meeting was held on November 2, 1951. Notices of Motion to amend the Articles of Association were discussed. The guest speaker, Mr. W. G. Meadley, Management Consultant, discussed "The Use of Management Technique in Agriculture". As scarcely any systematic work of this nature has been done in Australian agriculture, the address has been adapted for publication in this Journal*.

On December 7, 1951, the Branch held a garden party at the School of Agriculture to meet, entertain and welcome to the profession the new graduates of 1951.

Western Australia

A general meeting of the Western Australian Branch was held on 14th December when Mr. M. Cullity addressed members on his impressions of agriculture in the United Kingdom and Europe. His talk was well illustrated by a series of colour strip films taken during his travels. Mr. Cullity who is Superintendent of Dairying in the State Department of Agriculture, received an allocation of funds from the Commonwealth Dairying Efficiency Grant to enable him to study European dairy methods.

*Mr. Meadley's address is published elsewhere in this issue.

PERSONAL

Australian Capital Territory

Dr. D. O. Norris, of the Division of Plant Industry, C.S.I.R.O., Canberra, returned to Australia on November 11, after spending ten months overseas. Dr. Norris' main interest was in plant virus research, but he also paid visits to centres of other plant pathological research, particularly those dealing with the use of antibiotics against plant pathogens. He spent five months at Cambridge working with the Agricultural Research Council plant virus unit of Dr. Kenneth M. Smith. During this period visits were made to centres of virus research in Britain, Holland, France and Denmark. In August Dr. Norris flew to Canada and spent three months in visits to various Canadian and United States centres, including the pineapple and sugar cane research laboratories in Honolulu.

Mr. C. G. Greenham, who has recently been proxy councillor for Queensland, left Australia on the 21st December for a period of about nine months overseas. He will be visiting research institutions in England, Scandinavia and the United States. His special interests will be in the fields of plant hormones and herbicides.

Mr. R. D. Brock, Division of Plant Industry C.S.I.R.O., has been granted a C.S.I.R.O. Studentship to undertake work on cytology and genetics at the John Innes Horticultural Institute, England.

Mr. P. B. Carne, Division of Entomology, C.S.I.R.O., has been awarded a Wool Studentship for work in entomology at the University of Cambridge.

Dr. D. B. Williams recently returned from the United States after taking his Doctorate at the University of Illinois. His thesis on farm management was awarded one of the three $250 awards by the American Farm Economics Association for the best thesis on agricultural economics written in 1950.

Dr. Williams has joined the staff of the Bureau of Agricultural Economics, Canberra.

Mr. E. J. Johnston has commenced duties as Investigation Officer with the Bureau of Agricultural Economics. Prior to his recent appointment he was stationed at the C.S.I.R.O. Regional Pastoral Laboratory, Deniliquin, N.S.W., and was closely associated with soil survey work in irrigation districts in the Riverina.

New South Wales

Dr. A. R. Woodhill, Faculty of Agriculture, University of Sydney, has been awarded the degree of D.Sc. Agr. for work on the biology and systematics of Australian mosquitoes.

Dr. R. N. McCulloch, Principal of Roseworthy Agricultural College, has also gained the degree of D.Sc. Agr. for his research on the scrub typhus mite.

Mr. A. Johnson, Agronomist with the N.S.W. Department of Agriculture, has recently been transferred to Inverell as District Agronomist.

Dr. M. R. J. Salton, who is continuing his bacteriological research at Cambridge, was recently awarded the degree of Ph.D.

Professor P. R. McMahon has been appointed to the newly created chair of Wool Technology of the New South Wales University of Technology. Earlier this year Professor McMahon was appointed Associate Professor of Wool Technology.

Professor C. Zobell, from Scripps Oceanographic Institute California, has been visiting Sydney. Professor Zobell is Marine Microbiologist on the S.S. "Galatea", the investigational ship which is financed principally by subscriptions from the Danish people. While in Sydney the Professor gave a lecture and conferred with fellow microbiologists.

Professor H. C. Trumble, Professor of Agronomy at the University of Adelaide, has been in Sydney recently. The Professor, Australian representative at F.A.O., was in charge of a mission to Latin America to organise food production. Among the many interesting comments made by Professor Trumble was the statement of the extremely good work being done by E. C. Stakman, renowned rust worker, in connection with a Rockefeller Scheme involving increased food production in Mexico.

Mr. A. Pearson has been appointed Deputy Chief, Division of Plant Industry, in the N.S.W. Department of Agriculture.

Queensland

Mr. A. F. Bell, Under-Secretary of the Department of Agriculture and Stock, left Queensland in October on a 4-months visit overseas. He was a member of the delegation to discuss the renewal of the Sugar Agreement in London and is also studying general agricultural organization and development in England, the Continent, and U.S.A.

Mr. J. F. Miles, Plant Introduction Officer, C.S.I.R.O., is on an 18-months tour of the Mediterranean countries and Africa. He has made a complete circuit of the Mediterranean and in Africa has visited the Sudan, Ethiopia, Kenya, Tanganyika, the Gold Coast and Rhodesia. He is now in the Transvaal. Mr. Miles is studying pastures and pasture research and collecting plants intended primarily for use in Northern Australia.

Mr. W. R. Stern resigned in September from the Bureau of Sugar Experiment Stations and was appointed to the staff of the Katherine Experiment Station of C.S.I.R.O.

South Australia

A number of new appointments have been made to both the University and C.S.I.R.O. staff at the Waite Agricultural Research Institute.

Professor D. G. Catcheside has taken up his appointment to the Chair of Genetics in the University of Adelaide.

Dr. Jean Mathieson has also been appointed to the Department of Genetics at the Waite Institute.

New appointments to the Plant Pathology Department are *Dr. C. G. Hansford* as Head of the Department, *Dr. J. H. Warcup* as Senior Microbiologist and *Mr. A. Kerr* as Plant Pathologist.

Dr. R. J. Swaby has been appointed as Principal Research Officer in Charge of the Soil Microbiology Section of the Division of Soils.

Mr. N. G. Marinos recently arrived from the United States to take up an appointment in the Plant Physiology Department.

The staff of the Agronomy Department has been strengthened by the appointments of *Messrs. D. R. Bathe, W. E. Bond* and *R. J. Millington.*

Mr. J. T. Hutton of the Soil Chemistry Section of the Division of Soils has left Australia to visit research institutions in the United States and Great Britain.

Professor J. A. Prescott will be travelling to Great Britain in April. He expects to be away for six months.

Dr. T. O. Browning has been awarded a Nuffield Foundation Dominion Travelling Fellowship and will leave for England later in the year.

Oversea visitors who are spending some months at the Waite Institute include *Associate Professor E. R. Graham,* of the University of Missouri, who is visiting Australia under a Fulbright Award, and *Dr. H. L. Penman* of Rothamsted whose visit has been arranged by the Nuffield Foundation.

Western Australia

Dr. G. A. Currie, Vice-Chancellor of the University of Western Australia, left for India last December to attend a conference of Executive Officers of the Association of the Universities of the British Commonwealth.

Mr. J. J. Yates, Research Student at the Institute of Agriculture, has been awarded an I.C.I. Fellowship of two years duration to carry out research on the cyto-genetics of subterranean clover.

Mr. A. W. Humphries, George Aitken Research Student at the Institute of Agriculture, recently visited pastoral areas in South Australia and New South Wales in an endeavour to extend his collection of Swainsonas and other legumes native to Australia.

Victoria

Mr. W. R. Bettenay has transferred from Western Australia to join the Department of Commerce and Agriculture in Melbourne.

Mr. L. C. Scharp, Maffra Milk Co-operative, has taken a position as dairy engineer at the New York head-quarters of the United Nations International Children's Emergency Fund.

Miss Nancy Millis returned in January from England. She studied the microbiology of cider at Long Ashton Research Station and gained a Ph.D. degree of the University of Bristol.

Miss A. Vines has taken a position with the Queensland Department of Health and is engaged in a technical capacity at the Leprosarium on Thursday Island.

Mr. G. P. McGowan has returned to Victoria from Tasmania and is now farming at Upper Indigo, via Barnawartha.

Mr. T. W. Hogan, Biological Branch, Burnley, returned in September after 6 months abroad. He investigated work in entomology with special reference to insecticides at Rothamsted and the Imperial College of Science and Technology, attended the International Congress of Entomology at Amsterdam and spent some time in California on the way home.

Mr. E. Munch-Petersen has transferred from the Animal Health Research Laboratory, Parkville to the Institute of Agriculture, Western Australia. After many years' work on the bacteriology of mastitis, he will in his new position turn his attention to rumen flora. He has for some time contributed notably to the work of the Victorian Branch Committee.

Mr. A. L. Tisdall, formerly at the Regional Pastoral Laboratory, Deniliquin, has joined the Victorian State Rivers and Water Supply Commission.

Mr. W. F. Ritchie has been given 8 months leave of absence by "Stock and Land" to visit centres of agricultural research in the United Kingdom and on the Continent.

Mr. A. B. Cashmore, formerly Australian Liaison Officer for the Commonwealth Agricultural Bureaux, has been seconded for 7-9 months to an F.A.O. appointment in Cyprus to advise on range management, soil conservation and cropping.

Australian Scientific Societies and Professional Associations

The first of two directories, dealing respectively with Australian scientific societies and Australian research institutions, which are being prepared by the C.S.I.R.O., has now been issued as C.S.I.R.O. Documentation Section Pamphlet No. 1, by G. J. Wylie and Nona Lowe, under the above title. Copies may be obtained free of charge on application to the Senior Information Officer, C.S.I.R.O., 314 Albert Street, East Melbourne, C.2.

The second directory, covering Australian research institutions, is nearly ready for publication, and a further announcement will appear in this Journal when it is available.

British Commonwealth Scientific Conference

Senior representatives of Government scientific research organizations in British Commonwealth countries recently visited Australia to attend the British Commonwealth Scientific Conference. This Conference last met in London in 1946. Leaders in the fields of industrial, agricultural and medical research discussed Commonwealth collaboration in civil scientific work. The Conference was opened in Canberra by the Prime Minister on 18th February. After four days the delegates were taken on a four-day road tour to Melbourne through the Riverina and the Goulburn Valley, to enable them to see something of the Australian countryside and to study developmental problems. The Conference then continued in Melbourne until March 7.

Among those who attended may be mentioned: Sir William Slater, Secretary of the U.K. Agricultural Research Council; Dr. K. W. Neatby, Director of Science Service, Canadian Department of Agriculture; Dr. P. J. du Toit, President, South African Council for Scientific and Industrial Research; Dr. J. F. Filmer, Director, Animal Research Division, N.Z. Department of Agriculture, and Mr. R. McChlery, Division of Agriculture and Lands, Southern Rhodesia. Delegates from India, Pakistan and Ceylon were also present.

Arrangements for the Conference were made by the Commonwealth Scientific and Industrial Research Organization.

British Commonwealth Index of Scientific Translations

The British Commonwealth of Nations Scientific Liaison Offices in London have started a Commonwealth index of scientific translations. Each of the Commonwealth countries has or will have an agency, which is to maintain a central index of translations into English of published scientific papers, reports and journal articles which have been made by various organizations within the Commonwealth. Each agency collects details of translations made by the organizations in its own country that are co-operating in the scheme; the information is then passed on to the British Commonwealth of Nations Scientific Liaison Offices, London, where index cards are prepared and sent out to the agencies within the Commonwealth.

The Australian agency for this index is the Information Service, Commonwealth Scientific and Industrial Research Organization, 314 Albert Street, East Melbourne, C.2, Victoria.

Persons in Australia wishing to know if a certain translation is available should apply to the Senior Information Officer at the above address.

Radio-Isotopes for use in Australia

The following statement regarding the procurement of radio-isotopes from abroad for use within Australia is issued jointly by C.S.I.R.O. and the Commonwealth Department of Health.

A wide variety of radio-isotopes (including compounds labelled with a radio-isotope) is now available from U.S.A., Canada and Great Britain. These isotopes are of value in medical research, diagnosis, and treatment, in scientific investigations, and in industry. In many cases the use of radio-isotopes is associated with definite hazards to health, not only to those actually using them, but to those in adjacent rooms or even adjacent buildings. Particular care must be taken in the disposal of waste products from experiments involving the use of radio-isotopes. In addition to the danger to health, there is the risk of contamination of a laboratory which may make future investigations with radio-isotopes impossible.

The various overseas authorities producing radio-isotopes make them available only for projects in which they can be used safely and usefully. It is necessary that all applications should state clearly the purpose for which they are required, and approval is contingent on the provision of adequate safeguards against damage to health. Isotopes from U.S.A. and Canada can be obtained by foreign countries only through a definite channel in each country. In Great Britain isotopes are issued for local use by the Atomic Energy Research Establishment only after approval by committees set up by the Ministry of Health and the Medical Research Council, but in the case of exports to other countries the matter of approval has been left to the importing country. In most countries there is already some form of control of importation of radio-isotopes, the criterion for approval being that they can be used safely and profitably. In Australia, the Customs Department will permit the importation of a radio-isotope after production of a certificate issued under the authority of the Director-General of Health.

In consequence of the conditions governing the supply of isotopes C.S.I.R.O. and the Commonwealth Department of Health have arranged that applications for radio-isotopes for use in

Australia for medical and scientific purposes should be sent to the Commonwealth X-Ray and Radium Laboratory. After approval has been obtained orders will be placed with the supplying authorities through C.S.I.R.O. and its Australian Scientific Liaison Offices in London and Washington, and after arrival delivery will be made through the Laboratory, which will supply users with information regarding the dangers involved in the use of the particular isotope, and the means of safeguarding personnel. General advice on the availability and cost of particular isotopes, and the techniques of using them, will also be available from the Laboratory. The group of C.S.I.R.O. workers formerly associated with C.X.R.L. will in future be engaged on work connected with C.S.I.R.O. but, like all other C.S.I.R.O. officers, will, of course, be available for consultation in their own field.

Applications for isotopes should set out the name and address of the institution, and the name of the person ordering the material and responsible for its use, the quantity, kind, and chemical form of the isotope desired, and the approximate date at which it is required. A brief description of the purpose for which the isotope is to be used should include a statement of the experience in, and facilities for, the use of radio-isotopes.

Radio-isotopes are also becoming of use in industry, in the form of thickness gauges, static eliminators, etc., which involve equipment depending for their operation on radioactive sources. Such equipment is supplied from U.S.A. and Canada only by approval through the recognized channel. Manufacturers in Great Britain may export such equipment freely, but their importation into Australia will be dependent upon a certificate as to freedom from hazard to personnel.

Enquiries regarding the supply of radio-isotopes for use in medicine and in scientific investigations, and the importation of radioactive materials for use in industry should be made to The Director, Commonwealth X-Ray and Radium Laboratory, University of Melbourne, Carlton, N.3., Victoria.

Pacific Science Congress, 1953

The Eighth Pacific Science Congress is to be held in the Philippines during October-November, 1953. A special session is to be devoted to Crop Improvement in the Pacific area. Australian representatives on the Committee on Crop Improvement of the Pacific Science Council are Professor H. C. Trumble, Dr. O. H. Frankel, Mr. T. B. Paltridge and Dr. S. L. Macindoe.

Genetics in Adelaide

The appointment of Dr. D. G. Catcheside, F.R.S., to the newly-created Chair of Genetics in the University of Adelaide marks an important step forward in the development of Plant Genetics at the Waite Agricultural Research Institute. A separate department of Genetics was created at the Waite Institute early in 1950 with Mr. A. T. Pugsley as Senior Geneticist and Plant Breeder in charge. The supporting staff included Mr. G. M. E. Mayo as geneticist and Dr. K. Abele, formerly Professor of Botany in the University of Riga, as cytologist. The C.S.I.R.O. also seconded Dr. B. Horowitz to work on oil seeds in the department.

A new appointment to the department as geneticist is Dr. Jean Mathieson of the School of Botany of the University of Melbourne, who will work primarily on problems of fungal genetics.

These new developments have been made possible by the active co-operation of the Executive Committee of the C.S.I.R.O. which has guaranteed to the University the salary of the professorship for the first ten years. The department is expected to become the principal graduate training centre in plant genetics in Australia and the agreement between the University of Adelaide and the C.S.I.R.O. contemplates the establishment of a strong post-graduate school.

Professor Catcheside comes from the University of Cambridge, where he was Reader in Plant Cyto-genetics. He is well known for his work on the cytological and genetical effects of ionizing radiation and the biochemical genetics of *Neurospora*.

New Chief, Division of Plant Industry, C.S.I.R.O.

Dr. O. H. Frankel, D.Sc., D.Ag., F.R.S.N.Z., has taken up his appointment as Chief, Division of Plant Industry, C.S.I.R.O., in succession to Dr. B. T. Dickson.

Dr. Frankel came to Australia from New Zealand where for many years he was plant geneticist to the Wheat Research Institute which is a branch of the Department of Scientific and Industrial Research. His chief work there was in connection with the breeding of wheat for high yield and high baking quality. As a result of the Institute's research activities, New Zealand possesses a series of varieties well adapted to her windy climate, with high yield, and with a baking quality which has transfigured the New Zealand milling and baking industries. Whereas 20 years ago New Zealand's wheat on the whole was inferior to much of the Australian product, the situation is now reversed and New Zealand flour millers anxiously desire to become independent of Australian importations and to have a sufficiency of New Zealand grown wheat.

Dr. Frankel's personal interests are mainly in the fields of genetics and cytology. Soon after his arrival in New Zealand in 1929 he commenced a study of the cytosystematics of the New Zealand genera *Hebe* and *Veronica* which he has as yet not concluded, but which has led to a fuller understanding of the inter-relations in this complex group. During periods of work at the John Innes Horticultural Institution, U.K., he contributed to the knowledge of structural hybridity and of chiasma formation in *Fritillaria*. More recently he has published a number of papers on genic and chromosomal aberrations in *Triticum*, including new types of

speltoids, chromosome duplications and spontaneous gene mutants.

Throughout the years of his activity in New Zealand, Dr. Frankel took a lively interest in various phases of the theory of plant breeding. Earlier on he published a series of papers on the yield structure of wheat in New Zealand and in recent years made contributions to general discussions of theory and method in plant breeding. He is a keen advocate of plant collections as an aid to plant breeding and has contributed an article on this issue to this journal.

From 1942 to 1949 Dr. Frankel was responsible for the administration of the Wheat Research Institute and during the last two years of his stay in New Zealand for that of the Crop Research Division, D.S.I.R., which is responsible for research into problems of field and vegetable crops. He was twice President of the Canterbury branch of the Royal Society of New Zealand, was a member of the Dominion Council and is a Fellow of the Society. He was President of the New Zealand Genetical Society which was formed in 1949.

LETTERS TO THE EDITOR

HONORARY MEMBERSHIP OF THE INSTITUTE

Sir,

I was amazed to learn from the report of Council Proceedings published in the December 1951 issue of the Journal that "delegates generally felt that long service to the Institute rather than to agriculture was the important qualification for honorary membership."

Article 10 of the Institute's Articles of Association, which was amended only two years ago after full consideration by all Branches, now reads:—

> "Honorary members shall be persons who in the opinion of the Council of the Institute have rendered eminent service to Agriculture or to the profession of Agricultural Science in general or to this Institute in particular. At the discretion of Council honorary membership may be conferred for a period or for life."

Surely there is nothing there even to suggest that the Council should place emphasis on "long service to the Institute" and relegate to the background those who render eminent service only to agriculture or the profession! Such an attitude immediately eliminates from consideration practically all members not resident in a capital city, as well as numerous city members of considerable distinction.

Article 10 provides the Institute with the means of honouring members for service in various fields. The recipients to date number two—A. J. Vasey (for services to the Institute) and R. E. Soutter (for services to Queensland agriculture). One can understand the Council's desire to keep the Honorary Members list short, but it is to be hoped that members of the calibre of Soutter are not to be denied Institute honours because of a most unjust interpretation of Article 10 by the Council.

Yours, etc.

C. W. Winders.

Rainworth, Brisbane.

31. xii. 1951.

Sir,

While agreeing with Dr. Angell's conclusion in his technical note on Brown Rot of Stone Fruit (this Journal 17, 1951, 212-213) that trees vary in susceptibility to brown rot fungus, I do not consider that the facts presented in his note are sound support for his theory. On the basis of experiments with spray inoculations of fruit he concludes that heavy inoculum potential is not the factor responsible for infection. However, it is clear from his note that all the inoculations were carried out when the fruit were green. Experiments conducted by me in this Department for the past three years have shown quite clearly that apricots do not become susceptible to airborne infection until ripening commences, and therefore, inoculations conducted as early as those reported by Dr. Angell could not be expected to have any effect on the degree of infection. Before any valid conclusions could be drawn from this type of study I, therefore, suggest that the work should be repeated when the fruit have commenced ripening. If this has no effect on infection then Dr. Angell would be justified in drawing the conclusions given in his note.

Yours, etc.,

G. C. WADE.

Plant Pathology Division,
Department of Agriculture,
Hobart.
16-i-1952.

Sir,

Mr. Wade states that "In Tasmania apricots do not become susceptible to airborne infection until ripening commences". Conditions prevailing in some Canberra home orchards are very different from those prevailing in others, and the incidence of brown rot varies greatly. Severe loss from brown rot has been observed in some of these orchards six or more weeks before the expected time of ripening. One instance of total loss of immature fruit was observed by me in Canberra in the 1950-51 season while the spraying experiment under discussion was in progress. Brown rot also occurs on green fruit in Victoria in some seasons. Blossom blight was the subject of extensive spraying experiments in California by Rudolph.

Actually my spraying experiment would have been continued throughout the period of susceptibility of the fruit, including the ripening period, but the intervention of dry weather made its continuation pointless. Applying a spore suspension which would have dried in a few minutes would have been of doubtful value and would have justified criticism.

Yours, etc.,

H. R. ANGELL.

Division of Plant Industry,
C.S.I.R.O.,
Canberra.
23-i-1952.

DESTRUCTIVE AND USEFUL INSECTS — THEIR HABITS AND CONTROL

By C. L. METCALF and W. P. FLINT

(*McGraw-Hill Book Co., Inc., New York*, 1951, *3rd Edition, revised*, 1071 *pp.*)

The spectacular advances in economic entomology over the past decade have rendered out of date so many of the text books on the subject that this revised edition of one of the best known of them is a welcome addition to entomological literature.

R. L. Metcalf, son of one of the original authors and a noted research worker and lecturer at the Citrus Experiment Station, Riverside, California, has incorporated into the revision not only changes in control methods, but also recent developments in the subjects of insect physiology, internal anatomy and nutrition. The developments in these subjects have been quite considerable since the advent of the synthetic organic insecticides has stimulated research into their mode of action. At the same time, the development of resistance to some of the new insecticides by certain insects and the failure to achieve complete control with others have given added realization to the importance of biological control now, seen to be complementary to chemical control rather than antithetic. The treatment of biological control may be considered rather brief if this is regarded as a text book for students, but quite sufficient for those who use it as a reference book on applied entomology. It is interesting to note that the two outstanding examples of biological control of weeds are both Australian, viz., Prickly Pear and St. John's Wort; while the classical example of insect control by predators is the importation of the Lady Bird (*Rodolia cardinalis*) from Australia to California to control the Cottony Cushion Scale on citrus.

The new data and the widening of the subject matter to include such subjects as insect pigments has increased the size of the book to 1071 pages of which the first ten chapters (386 pages) are concerned with the general subjects of economic entomology including insect morphology, anatomy, physiology, systematics, apparatus for applying insecticides, and a chapter on insect control. Repellents, attractants, emulsifiers, activators and biological control are discussed in this chapter and a good feature is the inclusion of the structural formulae of the insecticides. The toxicity for rats and certain other animals is included in the properties of each insecticide and provides a useful reference, particularly now that the dangers of the indiscriminate use of insecticides are better realized.

The remaining thirteen chapters are concerned with specific insect pests, giving the plant attacked, distribution and a brief outline of their appearance, life history, habits and control measures. There is a key for the identification of the insects for each host, or host group.

The 500 insect pests described are, of course, those most common in U.S.A., but they include most of the more important pests in Australia, and in view of the excellent and up to date account of the general subject of economic entomology, this book can be recommended both for students and as a general text book on the subject.

T. W. HOGAN.

THE CLASSIFICATION OF WEST AFRICAN LIVESTOCK

By I. L. MASON

(*Commonwealth Bureau of Animal Breeding and Genetics Technical Communication No.* 7, 1951, *pp* 39. *Obtainable from the C.A.B. Liaison Officer at* 314 *Albert Street, East Melbourne, C.2. Price* 13/2.)

Those with world-wide interests in the nature of animal populations will regard "The Classification of West African Livestock" principally as an indication of more to come. It describes 22 different kinds of cattle and classifies them as belonging to one or other of four groups, two with and two without humps. It also describes three kinds each of horses, of sheep and of goats. The descriptions are illustrated by 38 excellent plates and there is a bibliography with 60 references. The booklet is an early contribution to the eventual publication by the Bureau of a World Dictionary of Breeds, Types and Varieties of livestock.

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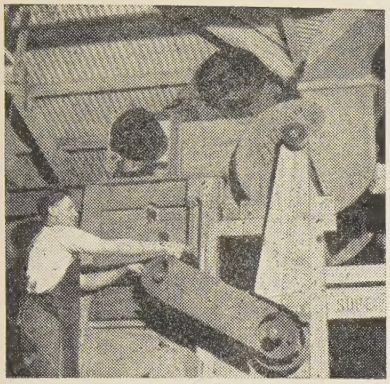

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